US Army Corps of Engineers
Seattle District

PSDDA Reports

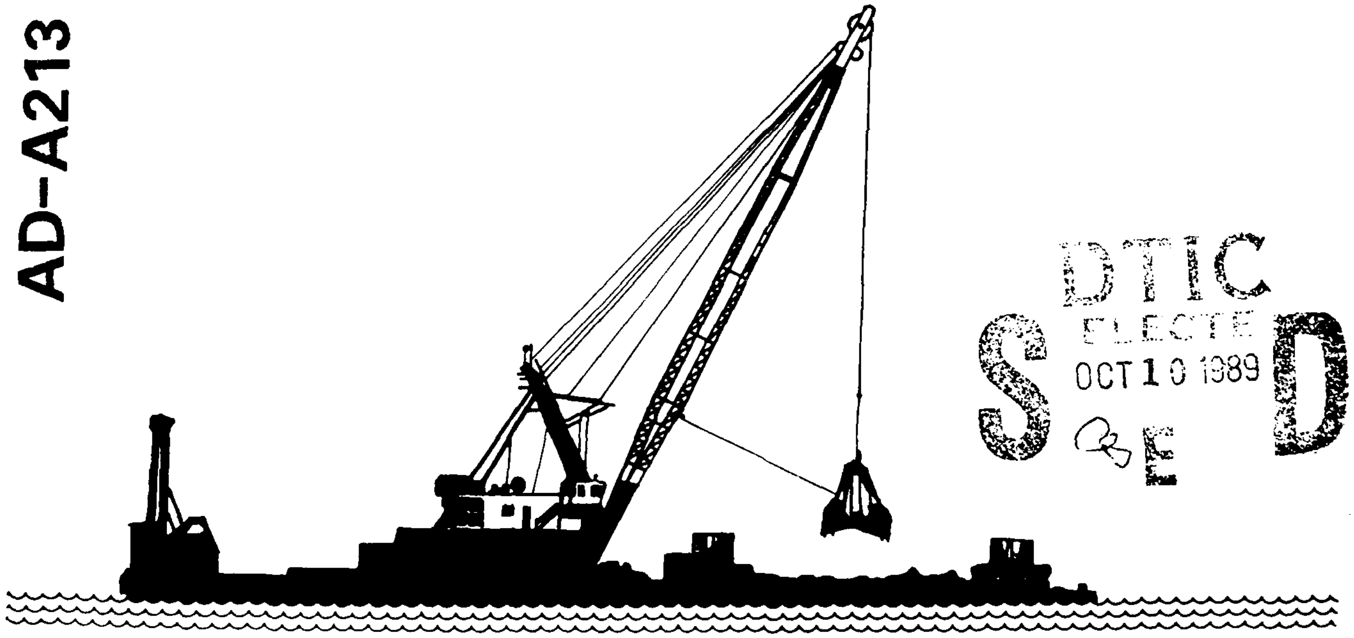
Puget Sound Dredged Disposal Analysis

Washington State Dept. of Natural Resources

MANAGEMENT PLAN REPORT

UNCONFINED OPEN-WATER DISPOSAL OF DREDGED MATERIAL, PHASE II

(NORTH AND SOUTH PUGET SOUND)



SEPTEMBER 1989

EPA Region 10

ECOLOGY

PUGET SOUND DREDGED DISPOSAL ANALYSIS
(PSDDA)

MANAGEMENT PLAN REPORT (MPR)
UNCONFINED, OPEN-WATER DISPOSAL OF DREDGED MATERIAL
PHASE II (NORTH AND SOUTH PUGET SOUND)

U.S. Army Corps of Engineers, Seattle District
U.S. Environmental Protection Agency, Region X
Washington State Department of Natural Resources
Washington State Department of Ecology

September 1989

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ACKNOWLEDGEMENTS

Participation by the following in the PSDDA study is gratefully acknowledged:

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• Major General Mark Sisinyak	North Pacific Division, U.S. Army Corps of Engineers
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ACKNOWLEDGEMENTS (con.)

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• David Mudd	Washington Department of Wildlife

ACKNOWLEDGEMENTS (con.)

• Pat Romberg	Metro
• Eric Johnson	Washington Public Ports Association
• Don Moos	Washington Public Ports Association
• Doug Hotchkiss	Port of Seattle
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• Leslie Sacha	Port of Tacoma
• Dennis Gregoire	Port of Everett
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• George Yount	Port of Port Townsend
• Donald Ellis	Port of Bellingham
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• Bob Barrick	PTI Environmental Services, Inc.
• Dr. D. Michael Johns	PTI Environmental Services, Inc.

THIS DOCUMENT CONTAINS THE
MANAGEMENT PLAN
FOR UNCONFINED OPEN-WATER DISPOSAL
OF DREDGED MATERIAL
PHASE II (NORTH AND SOUTH PUGET SOUND)

BOUND SEPARATELY IS THE FOLLOWING SUPPORTING TECHNICAL APPENDIX:

DISPOSAL SITE SELECTION

ALSO BOUND SEPARATELY IS THE
FINAL ENVIRONMENTAL IMPACT STATEMENT -
UNCONFINED, OPEN-WATER DISPOSAL
SITES FOR DREDGED MATERIAL, PHASE II
(NORTH AND SOUTH PUGET SOUND) (NEPA/SEPA)

PUGET SOUND DREDGED DISPOSAL ANALYSIS
PROPOSED MANAGEMENT PLAN REPORT FOR
UNCONFINED, OPEN-WATER DISPOSAL OF DREDGED MATERIAL
PHASE II (NORTH AND SOUTH PUGET SOUND)

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EXECUTIVE SUMMARY

This report contains the findings of Phase II of the Puget Sound Dredged Disposal Analysis (PSDDA), a comprehensive study of unconfined dredged material disposal in deep waters of Puget Sound. The study has been undertaken as a cooperative effort by the U.S. Army Corps of Engineers (Corps), U.S. Environmental Protection Agency (EPA), and the State of Washington Departments of Natural Resources (DNR) and Ecology (Ecology). A management plan for the Phase II area (North and South Puget Sound) is presented which identifies selected unconfined, open-water disposal sites, evaluation procedures for dredged material being considered for disposal at these sites and site management considerations including environmental monitoring.

The Corps, EPA, DNR, and Ecology began the PSDDA study in April 1985. The study was a 4-1/2-year-long effort, conducted in two overlapping phases, each about 3-1/2 years in length. As shown in figure 1, Phase I covered central Puget Sound, including the Sound's major urban centers, Tacoma, Seattle, and Everett. Phase II, initiated in April 1986, covered the north and south Sound areas, including Olympia, Port Townsend, Port Angeles, Anacortes, Bellingham, and other locations of dredging activity. Draft Phase I documents were prepared and distributed during January of 1988 for public review and comment. The final Phase I documents were released in June 1988. The draft Phase II documents were released for public review in March 1989. This final report and accompanying final Environmental Impact Statement reflect full consideration by the PSDDA agencies of comments received during public meetings conducted in April 1989 and those submitted in response to the draft documents.

Many elements of the PSDDA program are applicable to both the Phase I and Phase II areas. Some changes were made to the common elements through the Phase II process which reflect the most current intent of the PSDDA agencies. These changes are presented in this document (see chapters 5, 6, 7, 8 and 9).

PUGET SOUND NAVIGATION AND DREDGING

Navigation waterways of Puget Sound have played a vital role in the region's economic development and growth. Combined Port of Seattle and Port of Tacoma activity produces over 70,000 jobs and an annual business volume of nearly $4 billion. There are 34 port districts serving the region. Some 50 miles of navigation channels, about 30 miles of port terminal ship berths, and more than 200 small boat harbors must be periodically dredged to maintain the commercial and recreational services provided by these facilities. Over the period 1970-1985, an estimated 24.8 million cubic yards (c.y.) of sediments were removed from Puget Sound harbors and waterways by various dredgers. These included private developers and public entities (e.g., Federal and State agencies, ports, and local governments) responsible for funding and undertaking dredging projects. To place this activity in some perspective, periodic dredging for navigation improvement and maintenance projects occurred in only an estimated 0.08 percent or less than 2 square miles of the total 2,500 square mile surface area of Puget Sound.

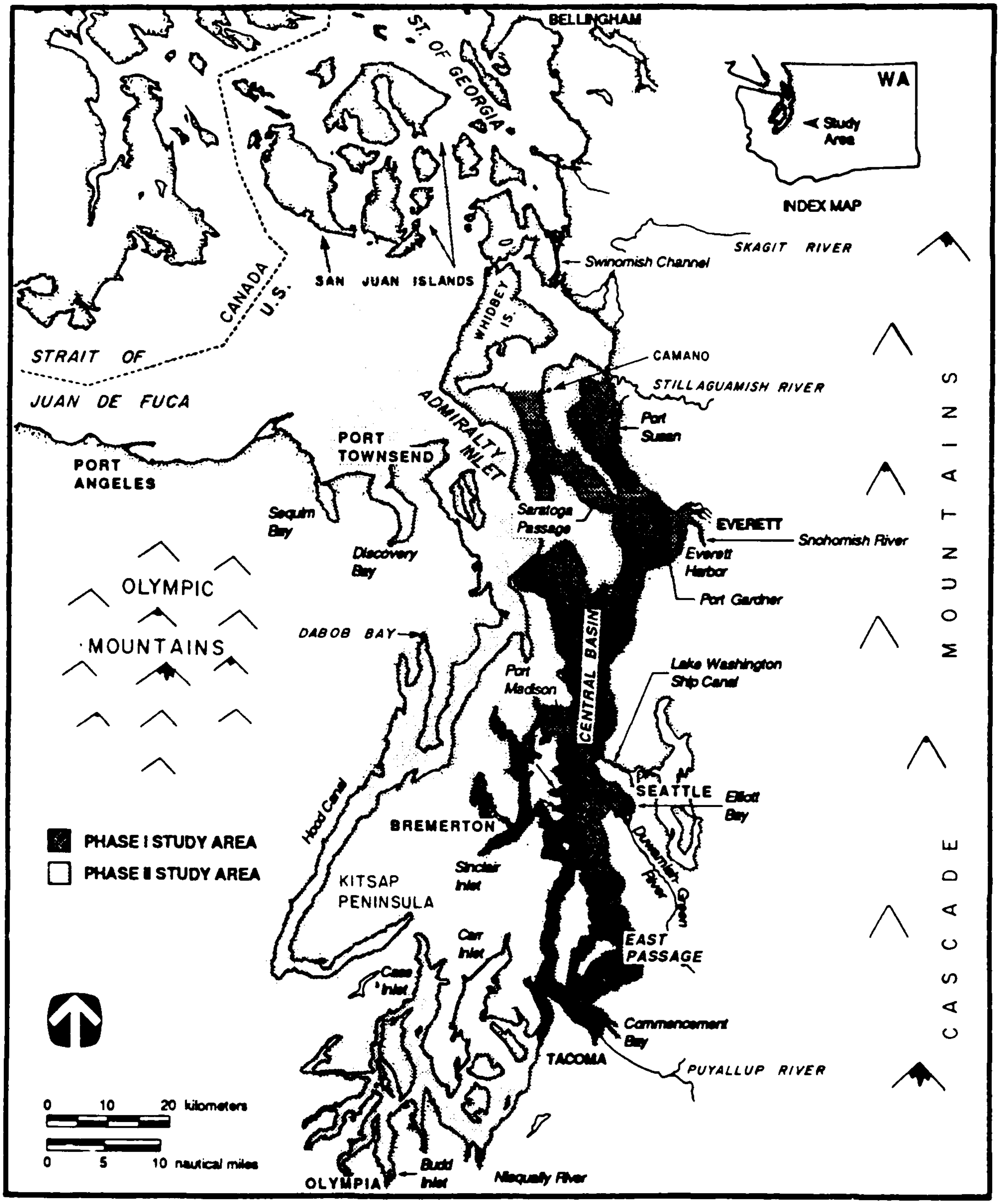


Figure 1. Study area -
Puget Sound Dredged Disposal Analysis

PUGET SOUND DREDGED MATERIAL DISPOSAL

Historic Practice. During early development of Puget Sound waterways, dredged material was often used as a convenient source of fill material for associated harbor and terminal improvements. This practice has continued, but at a much lesser rate in recent years, as public policy has been to protect environmentally important tidal areas, wetlands, and marshes. Consequently, nearshore disposal options are limited. Upland disposal is quite costly and may also have adverse environmental impacts. In the future, for many projects, disposal in deep and relatively deep marine waters is expected to be a preferred option for environmental, as well as economic, reasons.

Public Unconfined, Open-Water Disposal Sites. Until 1970, dredged material disposal in Puget Sound was discharged at sites generally selected by each dredger. At that time, disposal site designation guidelines were formulated by an interagency committee chaired by DNR, and more than 10 specific public multiuser disposal sites were established. Nearly all unconfined, open-water disposal has since occurred at these sites. In the 1970-1985 period, about 9 million c.y. or approximately 36 percent of the total material dredged was released at the designated disposal sites with most of the remaining material used as an economic source of landfill even though much of it would have been acceptable for open-water disposal. When compared with the 250 to 300 million c.y. of sediment that were discharged by the rivers flowing into Puget Sound over this same period, it can be concluded that only about 3 percent of the total annual sediment loading was due to dredged material disposal.

Key Regulatory Authorities. Section 404 of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 established a permit program, administered by the Secretary of the Army. This program is used to regulate the discharge of dredged material into waters of the United States. It also is used to specify disposal sites in accordance with Section 404(b)(1) Guidelines developed in interim final form by EPA in 1975. The Guidelines concentrated on specifying the tools to be used in evaluating and testing the impact of dredged or fill material discharges on waters of the United States. In 1977, the FWPCA was substantially amended as the Clean Water Act (CWA). In 1980, EPA, in conjunction with the Corps published final Guidelines for the specification of disposal sites for dredged or fill material. These specify that the disposal of dredged material must not result in an "unacceptable adverse impact" to aquatic ecosystems. Simultaneously, proposed rules for testing requirements were published. Although final rulemaking has not taken place, the testing requirements and procedures have been implemented by the Corps as a matter of policy.

Congress granted to the States the responsibility for certifying under Section 401 of the CWA that a proposed discharge, resulting from a project described in a Corps public notice issued under Section 404 of the CWA, will comply with the applicable provisions of the State and Federal water quality laws. This certification is required for any Federal activity, and from any applicant for a Federal permit to conduct any activity, which may result in any discharge into State waters. Compliance with Section 401 also ensures that any such

discharge will comply with the applicable provisions of Sections 301, 302, 303, 306, and 307 of the CWA and relevant State laws.

Dredged Material Research. Considerable nationwide research has been accomplished since the early 1970's through the Corps' Dredged Material Research Program (DMRP) in assessing the environmental effects of dredged material disposal. This research has been used by the Corps in making decisions on dredged material disposal. DMRP has shown that most dredged material is suitable for open-water disposal and can have many beneficial uses, including fish and wildlife habitat development. As part of the DMRP, studies were conducted in Elliott Bay and elsewhere in Puget Sound. Puget Sound examples of beneficial use of dredged material include Jetty Island at Everett, clam habitat development at Oak Bay Canal, and a beach feed erosion control project at Keystone Harbor on Whidbey Island.

SITUATION LEADING TO PUGET SOUND DREDGED DISPOSAL ANALYSIS

Past Dredged Material Evaluation. Until 1984, Puget Sound dredged material sampling, testing, and test interpretation requirements were established on a project by project basis. EPA and the Corps, in cooperation with Ecology, assessed non-Corps dredging projects. The Corps conducted the evaluations for federally authorized Corps navigation projects. (For the purposes of this report, federally authorized navigation projects include Corps projects authorized under various River and Harbor Acts as well as all other federally operated channels such as Navy, U.S. Coast Guard, NOAA, etc.) In the case of Corps navigation projects, Seattle District developed testing procedures for each project in cooperation with Ecology and EPA. These procedures, developed programmatically for Corps projects, were also required, as appropriate, for non-Corps permit applicants.

Case-by-case evaluations did not provide local authorities with sufficient assurance that aquatic resources at the disposal sites were being adequately protected. The Puget Sound area is unique relative to other regions of the Nation in that local governments also play a key role in dredged material disposal through their shoreline master programs under the State shoreline permit process. Local jurisdictions can condition or restrict dredging and dredged material disposal.

The lack of fully consistent evaluation procedures, or specific objective decision criteria led, in part, to the establishment of interim disposal criteria by EPA and Ecology for the Fourmile Rock disposal site in Seattle's Elliott Bay in 1984 and the Port Gardner site near Everett in 1985. The Fourmile Rock criteria became a condition of the local shoreline permit issued by the city of Seattle and the Port Gardner criteria a condition of the city of Everett permit for the existing Port Gardner site. Subsequently, in 1985, Ecology developed the Puget Sound Interim Criteria (PSIC) to ensure that the other Puget Sound disposal sites did not experience similar problems. These criteria have been used in the interim pending development of regional Sound-wide guidelines for dredged material disposal.

Closure of Disposal Sites. The Fourmile Rock and Port Gardner disposal sites were closed in 1984, due in part to public controversy associated with use of these particular locations. While the Fourmile Rock site was reopened in 1985, it closed again in June 1987, when the shoreline permit for the site expired. The Commencement Bay site closed in June 1988. New Phase I area disposal sites became available in October 1988 at Commencement Bay and Port Gardner, and March 1989 at Elliott Bay. Use of these sites is subject to compliance with the dredged material management plan adopted by the PSDDA agencies in June 1988. As of August 1989 there were no disposal sites available in the Phase II area. Former sites, located at or near Admirality Inlet, Bellingham Bay, Bellingham Channel, Padilla Bay, Skagit Bay, Steilacoom and Port Angeles were all closed by May 1989. Until the new sites, identified through the PSDDA process, have been permitted by local shoreline jurisdictions, dredgers in the Phase II area will either have to find their own site and obtain a separate local shoreline permit for disposal or transport dredged material found suitable for unconfined open-water disposal to a Phase I site. This condition creates uncertainty with regard to future disposal of dredged material in the Phase II area, and highlights the urgency of having shoreline permits for the new sites, if maintenance of navigation channels is to continue.

Puget Sound Pollution and Contaminated Sediments. The past practice of discharging untreated or only partially treated industrial and municipal effluent into Puget Sound, combined with potentially harmful chemicals from a variety of other point and nonpoint sources, has resulted in the degradation over time of the water and sediment quality in some areas of Puget Sound. Increasing scientific evidence about the harmful effects of pollution on the estuary has served to heighten public and agency concern about the long term environmental health of the estuary and the impact that various activities can have on the Sound's ecosystem. Recent efforts to establish better regulatory control of pollutants at their source have resulted in general improvements in water quality. Additionally, ongoing planning and cleanup actions by the Puget Sound Water Quality Authority (PSWQA), Ecology, EPA, local governments, and others are expected to further improve the marine environment. Concerns remain, however, because the sediments near industrialized and developed areas may remain contaminated from past waste discharge practices. This is because potentially harmful and persistent chemicals tend to bind to the sediment particles and settle to the bottom. While considerable improvements have been made, more remain to be accomplished.

Data indicate that pollutants, which have entered the major harbor areas through various sources, have accumulated over time in a variety of shoreline areas, including navigation channels and vessel berthing locations. Dredging, in the process of maintaining the Sound's navigation system, must sometimes involve the removal and disposal of contaminated sediments.

The PSDDA study has recognized the requirement for dealing with contaminated sediments. However, the study focus has been primarily on disposal of the majority of dredged material which is expected to be found relatively "clean," and therefore acceptable for unconfined, open-water disposal at designated

public multiuser sites. These are locations where any dredger can dispose of dredged material, provided that the material has been evaluated and disposal approved by the appropriate regulatory agencies. A separate study by the State of Washington is underway which is addressing the specific requirements of dredged material found unacceptable for disposal at the PSDDA designated sites.

PUGET SOUND DREDGED DISPOSAL ANALYSIS (PSDDA)

Environmental and economic considerations are both major factors supporting the need for long range regional planning as a lasting, effective solution for dredged material disposal problems. No longer can disposal alternatives be planned independently for multiple projects in a given area. Regional dredged material disposal management programs offer greater opportunities for environmental protection, reasonable project costs, and greater public acceptance than total case-by-case decisionmaking. A dredged material disposal management plan for unconfined, open-water disposal was completed in June 1988 for the Phase I area. A plan for the Phase II area has also been developed through the PSDDA study. These plans are unique to the Puget Sound area because the data supporting many elements of the plans are Puget Sound based. Also the plans reflect the social values of this region and are responsive to the unique role, from a national perspective, of local government in the management of open-water dredged material disposal sites.

Study Goal and Objectives. The goal of PSDDA is to provide publicly acceptable guidelines governing environmentally safe unconfined, open-water disposal of dredged material, thereby improving consistency and predictability in the decisionmaking process. Public acceptability involves consideration of a wide range of factors. Among these are technically sound evaluation procedures and practicability, which includes cost effectiveness. Study objectives are to: (1) identify acceptable public multiuser unconfined, open-water disposal sites; (2) define consistent and objective evaluation procedures for dredged material to be placed at those sites; and (3) formulate site use management plans that will ensure adequate site use controls and program accountability.

Study Limitations. The PSDDA Federal and State agencies have identified disposal sites and site management plans only for unconfined, open-water disposal. Locations for conventional upland/nearshore sites and confined disposal sites (confined aquatic or upland/nearshore) have not been specified. There are several reasons for this. First, disposal in Puget Sound waters principally involves Federal and State authorities while disposal on land (especially for contaminated material) is very much associated with local government decisions regarding land uses. And second the State of Washington, in a study initiated in 1988, is addressing confined disposal options and associated testing procedures, building on the work done through PSDDA.

An evaluation comparing the potential impact of dredged material disposal to the impacts of other water-related activities in Puget Sound is also beyond

the scope of this study. However, due to the limited areas to be dredged and the conditions imposed by regulatory agencies, dredged material disposal at unconfined, open-water sites has very little potential for affecting the overall ecosystem of Puget Sound. This conclusion is supported by information derived from the PSDDA study and presented in study documents.

PSDDA PHASE II (NORTH AND SOUTH PUGET SOUND)

Study Findings. The following are key findings of the PSDDA study for the Phase II area:

- About 7.2 million cubic yards (c.y.) of bottom sediments could be removed from Phase II area harbors and waterways over the period 1985-2000 as compared to the 7.9 million c.y. removed between the years 1970 to 1985.

- The management plan for the Phase II area addresses the needs of unconfined, open-water disposal including (a) disposal site locations, (b) dredged material evaluation procedures, (c) disposal site management, (d) disposal site environmental response monitoring, and (e) dredged material data management.

- The PSDDA goal and study objectives are met by the Phase II plan.

- Specific project by project evaluations, to be made under the Section 404(b)(1) Guidelines and Section 401 Water Quality Certification review, will establish actual dredged material volumes that can be placed in unconfined, open-water disposal sites. However, through the year 2000, based on PSDDA projections and estimates, about 6.2 million c.y. of future Phase II area dredged material is expected to be found acceptable for unconfined, open-water disposal. This compares with 3.2 million c.y. of dredged material actually placed in Phase II waters over the past 15 years. In the past, not all acceptable material was placed at public open-water disposal sites. Much was used for landfill or other beneficial purposes. This is anticipated in the future, too.

- The PSDDA disposal sites can accommodate the projected volumes of acceptable dredged material well beyond the year 2000.

- More extensive dredged material sampling and testing will be required than in the past, as well as improved disposal site management, including increased permit compliance inspections and environmental monitoring of site impacts. Overall, the cost of dredged material disposal is anticipated to be higher than it was prior to the establishment of the EPA/Ecology interim criteria, but less than that experienced under the interim criteria. More dredged material is expected to be found acceptable for unconfined, open-water disposal under PSDDA evaluation procedures as compared to the interim criteria. Other disposal options, including confined aquatic capped, nearshore, and upland disposal are generally much more expensive because of greater handling and transport requirements, and the increasing difficulty in securing acceptable site locations. From a regional standpoint, the reduced

disposal costs are expected to more than compensate for increased costs of sampling, testing, and disposal site management.

- Environmental consequences were considered as various elements of the management plan were addressed. This is reflected in the disposal site locations, as well as the disposal guidelines chosen for site management. Environmental impacts resulting from disposal at the identified sites are not expected to be significant, as discussed in the PSDDA Phase II Environmental Impact Statement (EIS).

- The Phase II plan fully complies with the Clean Water Act and its objectives to restore and maintain the environmental quality of the Nation's waters. It is also in consonance with all applicable State and Federal laws and the PSWQA-adopted 1987 Puget Sound Water Quality Management Plan.

- Indian treaty fishing rights have been addressed and properly protected.

Management Plan. Key elements of the PSDDA management plan for the Phase II area are:

- Public Multiuser Unconfined, Open-Water Disposal Sites. Five public multiuser unconfined, open-water disposal sites have been selected which will partially satisfy the future dredged material disposal needs of the Phase II area. Because the Phase II area contains only a few urban and industrialized centers of development where significant waste discharges have occurred, over 85 percent of this area's future dredged material may be found acceptable for unconfined, open-water disposal. This compares with about 70 to 80 percent anticipated for the Phase I area and 90 to 95 percent nationally. The estimate of acceptable material for the Phase II area is based on existing data, primarily surface sediment chemistry, which tends to indicate higher contamination levels than exist in deeper portions of the dredging prism.. Actual volumes may be more or less, and will depend on test results and subsequent evaluations by regulatory agencies. Unacceptable material will need to be confined in aquatic capped, nearshore, or upland facilities. For some projects, the high cost of confined disposal may preclude their undertaking. This has a potential for adverse economic and social impacts as many projects are important to local communities as well as the region.

All the disposal sites in the Phase I area are located in nondispersive environments where bottom currents are very low. Dredged material placed at these sites can easily be monitored as the material will tend to stay on site. In the Phase II area it was not possible to locate all disposal sites in nondispersive environments. Three of the Phase II sites are located in very high current or dispersive environments where dredged material is likely to be swept from these sites within several tidal cycles. Monitoring of dispersive sites, except for disposal mound formation, is not practical.

Nondispersive unconfined, open-water disposal sites have been selected in the Nisqually Delta region between Anderson and Ketron Islands, and in Bellingham Bay. Dispersive sites have been identified in Rosario Strait, and near Port

Townsend, and Port Angeles. A dispersive site, considered near Point Roberts, was dropped due to potential conflicts with the commercial trawl fishery in that area. The nondispersive sites vary in size primarily due to bathymetry. The Bellingham Bay site has a 260-acre potential bottom impact area and the Anderson/Ketron Island site a 318-acre impact area. Each nondispersive site includes a 900-foot radius, 58-acre surface disposal zone within which all dredged material must be released. The dispersive sites range in size from 650 acres at Rosario Strait to 884 acres at Port Angeles and Port Townsend. Each of the dispersive sites includes a 1,500-foot-radius, 162-acre surface disposal zone within which all dredged material must be released.

The Phase II disposal sites were located, to the maximum extent practicable, in areas with few important biological resources and human use activities. In Rosario Strait, the center of the disposal zone is located about 2 nautical miles south of Reef Point on Cypress Island in water 230 feet deep. The center of the Port Townsend disposal zone is located approximately 10-1/2 nautical miles northwest of Port Townsend in water about 360 feet deep. The center of the Port Angeles disposal site is located about 4-1/2 nautical miles north of Port Angeles is about 430 feet of water. In South Sound, the center of the selected disposal zone is located mid way between Anderson and Ketron Islands in water about 440 feet deep. The selected site in Bellingham Bay is located about 3-1/2 nautical miles southwest of Bellingham in water about 100 feet deep.

- Evaluation Procedures. Comprehensive dredged material evaluation procedures governing sampling, testing, and test interpretation (disposal guidelines) have been developed through PSDDA to ensure that conditions at the disposal sites are consistent with site management objectives. The evaluation procedures are intended to be used, as appropriate, in support of assessments of specific projects conducted under the Federal Section 404(b)(1) Guidelines and under the State of Washington guidelines used in evaluating projects for Section 401 Water Quality Certifications. At the two Phase II nondispersive sites, procedures will be the same as currently in use for the Phase I nondispersive sites. For the three Phase II dispersive sites a modification of the Phase I evaluation procedures is proposed which results in a more restrictive guideline. This was deemed appropriate because of the inability to accomplish the same degree of monitoring as is possible at the nondispersive sites.

- Site Management Plans. Disposal site management plans have been formulated to address navigation and discharge conditions of disposal permits, and subsequent disposal site environmental monitoring. The Phase II monitoring plan is intended to ensure that acceptable conditions at the sites are not exceeded and to provide a basis for any necessary adjustments to site management plans.

Alternatives. The EIS accompanying this report describes and evaluates the selected and alternative disposal sites. A No Action alternative is presented which would continue use of the PSIC by Ecology and EPA for dredged material disposal. This alternative would result in very limited unconfined,

open-water disposal in the Phase II area of Puget Sound due to both the application of the PSIC and the discontinuation of public multiuser disposal sites.

The No Action alternative could result in no dredging for some projects as other disposal options may be cost prohibitive. Social impacts could include lost employment and reduced property values. Some adverse environmental impacts may also occur during the construction of new facilities, even in those areas where marine facilities can be relocated to waters accessible to navigation without dredging.

Environmental Analysis. The disposal sites were selected based on careful consideration of a number of factors, including biological resources, human uses, physical parameters, and haul distances from dredging projects. The selected sites are in locations where significant adverse environmental impacts to the quality of the human environment (per the National Environmental Policy Act (NEPA)) are not anticipated, and human use conflicts have been minimized to the extent practicable.

The environmental impacts associated with disposal site use based on the proposed dredged material evaluation procedures were also examined. The selected disposal guidelines will not result in unacceptable adverse impacts. A full discussion of the environmental impacts associated with the alternatives is contained in the EIS. An EIS was prepared to "encourage and facilitate public involvement in decisions which affect the quality of the human environment" (40 CFR 1500.2).

Implementation. The Corps and EPA will share, with the State of Washington, responsibility for implementation of the PSDDA management plan for the Phase II area. DNR and Ecology, as well as Pierce, Clallam, Skagit and Whatcom Counties will perform the non-Federal functions. DNR will obtain shoreline management permits from the counties for the selected sites for the maximum possible period (currently 5 years). Responsibility will be shared by DNR with the Corps for site management, with DNR generally performing chemical and biological environmental monitoring of the nondispersive sites. Baseline studies of the nondispersive sites will be accomplished by Ecology. Ecology will also use the appropriate PSDDA dredged material evaluation procedures as a basis for Section 401 Water Quality certification determinations, and will work in conjunction with Seattle District Corps in including Phase II data in the dredged material data management system established as part of the phase I management plan.

The Corps and EPA will use the appropriate aspects of the PSDDA evaluation procedures to guide their respective activities under Section 404. Also, the Corps will be generally responsible for physical monitoring of both the dispersive and nondispersive disposal sites and developing and maintaining a dredged material data management system for Puget Sound that is intended to meet the needs of all the PSDDA agencies.

Implementation of PSDDA evaluation procedures began for Phase I area projects during the fall of 1988 and is expected to begin for Phase II area projects by the fall of 1989. The selected Phase II disposal sites are expected to be available for use by the winter of 1989, after approval of shoreline permits by local governments (Whatcom, Skagit, Clalla and Pierce Counties) and Ecology.

Advance identification of the PSDDA disposal sites was accomplished concurrent with public review of the Phase II draft documents by EPA and the Corps under subpart I of the Section 404(b)(1) Guidelines (40 CFR 230.80). Under this action a determination has been made that the selected Phase II disposal sites are suitable for future disposal of dredged material. The FEIS contains the final determination of suitability.

Review and Revisions. The PSDDA agencies recognize that the state-of-the-art of dredged material testing and test interpretation continues to rapidly change. Accordingly, provision is made in the Phase II management plan for annual assessments of the data obtained through the regulatory actions on specific dredging projects, as well as the information gained from environmental monitoring of the disposal sites after they have been in use. These assessments combined with assessments resulting from Phase I disposal projects, will be conducted by the PSDDA agencies with opportunities provided for participation by other interested agencies, organizations, and private citizens. The assessments will provide the basis for appropriate revisions to the PSDDA management plans. Sediment evaluation procedures, site environmental monitoring, and cost aspects of the plans will be reexamined. One result may be a reduction in the level of testing and monitoring, if that is possible without compromising the environmental mandate of the CWA and applicable State authorities.

Study Documents. The primary Phase I PSDDA study documents include this report containing the management plan for the Phase II area, a technical appendix which provide detailed information in support of the plan elements involving disposal site selection, and a FEIS focusing on the alternative disposal sites considered for the Phase II area and probable impacts associated with their use for dredged material disposal.

- Management Plan Report - Unconfined Open-Water Disposal of Dredged Material Phase II (North and South Puget Sound). This document describes the study authorities, background, goal, objectives, and planning process which resulted in the PSDDA management plan. The plan is presented with expanded coverage given to major program elements. A discussion on the implementation of the management plan is included.

- Disposal Site Selection Technical Appendix - Phase II (North and South Puget Sound). A detailed description of the disposal site selection process is provided along with information on the existing disposal sites and alternative sites considered.

- Final Environmental Impact Statement (NEPA/SEPA) - Unconfined, Open-Water Disposal Sites for Dredged Material, Phase II, (North and South Puget Sound). This document presents and evaluates the selected Phase II area unconfined, open-water disposal sites and alternative sites considered.

PUGET SOUND DREDGED DISPOSAL ANALYSIS
PROPOSED MANAGEMENT PLAN FOR
UNCONFINED, OPEN-WATER DISPOSAL OF DREDGED MATERIAL
PHASE II (NORTH AND SOUTH PUGET SOUND)
DRAFT REPORT

CHAPTER 1. AUTHORITIES

1.1 Study Authority. This chapter presents the specific authorities by which the Seattle District, U.S. Army Corps of Engineers (Corps); Region X, Environmental Protection Agency (EPA); Washington Department of Natural Resources (DNR); and the Washington Department of Ecology (Ecology) are participating in the Puget Sound Dredged Disposal Analysis (PSDDA) Study.

1.1.1 Federal Authorities. The Corps has regulatory authority over waters of the United States. This includes dredging and disposal of dredged materials in navigable waters of the United States, such as Puget Sound. The Corps' authority to issue or deny permit applications stems from Section 10 of the River and Harbor Act of 1899 and Section 404 of the Clean Water Act (CWA) (Public Law 92-500, as amended). Section 404 authorizes the Secretary of the Army, acting through the Corps, to issue permits for the discharge of dredged or fill material into waters of the United States. These permits specify disposal sites for dredged material determined to be suitable for discharge into waters of the United States in accordance with the Section 404(b)(1) Guidelines (discussed below). Section 404(b)(2) of the CWA allows the Corps to issue permits otherwise prohibited by the guidelines, based on consideration of the economics of anchorage and navigation. The public interest review process used by the Corps provides for consideration of a number of factors in permit and project decisions. Permit decisions will be based on an evaluation of probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest (33 CFR 320.4). Via this weighing and balancing process, a permit decision is influenced by broad considerations. For activities involving Section 404 discharges, a permit will be denied if the discharge that would be authorized by such a permit would not comply with the Section 404(b)(1) Guidelines (subject to the Section 404(b)(2) exception).

EPA, in conjunction with the Corps, develops guidelines for the implementation and use of disposal sites under Section 404(b) of the CWA. EPA is authorized by Section 404(c) of the CWA, after notice and opportunity for public hearings, to prohibit or restrict the use of a disposal site whenever it determines that the discharge of such materials will have "unacceptable adverse impacts" on municipal water supplies, shellfish beds and fisheries, wildlife, or recreational areas.

The overall guidelines for specification of disposal sites for dredged material are the Section 404(b)(1) Guidelines (40 CFR Part 230), which require consideration of numerous factors prior to allowing disposal of dredged material in waters of the United States. Subpart G of the Section 404(b)(1)

Guidelines provides guidance for evaluation and testing of dredged material to be disposed into waters of the United States. The studies undertaken to develop the PSDDA evaluation procedures were based primarily on the evaluation and testing requirements of the Guidelines (see chapter 5 of the Phase I MPR).

The National Environmental Policy Act (NEPA) requires all Federal agencies to assess the environmental impacts of major Federal actions significantly affecting the quality of the human environment and to consider all reasonable alternatives. The Coastal Zone Management Act (CZMA) (Public Law 92-583) requires that Federal projects be consistent to the maximum extent practicable, with the State's coastal zone management program. For non-Federal projects, full consistency is required.

The integration of environmental considerations into the planning process concurrent with the evaluation of economic, social, and technological aspects of a proposal or plan is called for by NEPA. The procedural requirements of these laws specify the documentation and disclosure of this integrated assessment when recommending or proposing an agency action (unless such action is of minor consequence to the environment and is categorically excluded from this assessment). The extent of the documentation is dependent on the degree of potential adverse environmental effects resulting from the proposal. Per NEPA, an environmental impact statement (EIS) is required "in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment" (40 CFR 1502.3). The term "significantly" requires consideration of both "context" (affected region, affected interests, and locality) and "intensity" (degree, controversy, persistence, geographic extent, etc. of effects) (40 CFR 1598.27). EIS's may be needed for specific project proposals, or may be prepared for broad Federal actions (such as the adoption of programs that affect larger geographic areas (i.e., a large water body such as Puget Sound), or that generically involve many similar actions (40 CFR 1502.4)).

NEPA includes "planning to avoid and minimize adverse effects" as one aspect of "mitigation." The PSDDA agencies sought to avoid and minimize any potential adverse effects of the Management Plan for the Phase II area through careful development of plan elements. Consequently, the Phase II plan elements are, in part, mitigation features of dredged material management in Puget Sound. They are consistent with the goal of environmental protection and the objectives of the CWA. Mitigation that reduces the probable adverse impact to less than significant levels can be a basis for deciding that an EIS is not warranted (as long as the mitigation is an integral part of the original proposal), though NEPA rules discourage this approach.

The decision to prepare environmental impact statements for the Phase I and II study areas was not based on an *a priori* determination that the resulting adverse effects would be "significant." It was recognized that the environmental impacts will depend on where disposal sites are located and the disposal guidelines that will be used in disposal site management. Accordingly, the agencies participating in the PSDDA study agreed to prepare impact statements to "encourage and facilitate public involvement in decisions

which affect the quality of the human environment" (40 CFR 1500.2). The PSDDA plan of study notes that an EIS will provide "the basis for subsequent implementation actions" by the PSDDA agencies (see chapter 9).

The Section 404 Guidelines also allow advance identification of areas suitable (or not suitable) for discharge of dredged material (40 CFR 230.80). Exhibit B of the DEIS contains a Public Notice: "Initial Determination of Suitability for Disposal of Dredged Material in waters of North and South Puget Sound," issued under this authority by the Corps and EPA.

1.1.2 State Authorities. The State of Washington's authorities related to dredged material disposal are both regulatory and proprietary. The State's regulatory authority stems from the CWA and CZMA, and from the State Water Pollution Control Act and Shoreline Management Act (SMA).

Congress granted to the States the responsibility for certifying under Section 401 of the CWA that a proposed discharge, resulting from a project described in a Corps public notice issued under Section 404 of the CWA, will comply with the applicable provisions of State and Federal water quality laws. This certification is required for Federal activities, and from any applicant for a Federal permit to conduct any activity, which may result in any discharge into State waters. Compliance with Section 401 also ensures that any such discharge will comply with the applicable provisions of Sections 301, 302, 303, 306, and 307 of the CWA and relevant State laws.

In particular, Section 303 of the CWA provides for establishment of State water quality standards. The existing State of Washington standards reflect the State's policy to maintain the highest possible standards to ensure the purity of all waters of the State. This public policy, as enunciated in the State's Water Pollution Control Act (90.48 RCW), was established to protect public health and public enjoyment of the State's water. The standards recognize the need to protect the purity of water for wildlife, birds, game, fish and other aquatic life and for the industrial development of the State. To these ends the State requires the use of all known available and reasonable methods by industry and others to prevent and control the pollution of the waters of the State of Washington. Consistent with this policy the State of Washington exercises its powers, as fully and as effectively as possible, to retain and secure high quality for all waters of the State.

The State of Washington's Water Pollution Control Act designated the Department of Ecology as the agency for carrying out all State responsibilities of the CWA as amended. Pursuant to Section 303 of the CWA, Ecology has established water quality standards for the State (WAC 773-201). Among other requirements, the standards do not allow the discharge of toxic or deleterious material which may affect the natural aquatic environment.

Ecology establishes guidelines for State and local administration of the SMA (RCW 90.58). Ecology ensures that permits issued by local governments are consistent with the intent of the act. Issuance of a shoreline permit also enables Ecology to certify a project's consistency with the CZMA.

The State's aquatic land proprietary authority is administered by DNR (RCW 43.30 and Title 79). DNR manages tidelands and bedlands of Puget Sound, including the disposal sites. Regulations for designating State-owned aquatic land sites for open-water disposal and proprietary use fees have been established in WAC 332-30-166.

DNR designates acceptable disposal sites, secures a local shoreline permit (also providing CZMA consistency) for use of each site, issues individual use authorization to each disposal site user (other than the Corps), and manages site use. Site designation has been historically accomplished by an interagency siting committee established and chaired by DNR. The Corps participates on this committee and has generally utilized the State-designated sites for Federal dredging projects. Corps approval of disposal site use depends on a finding of compliance with the CWA Section 404(b)(1) Guidelines.

The State Environmental Policy Act (SEPA RCW 43.21c) requires consideration of environmental impacts of taking "actions" as defined by the regulations. Policies set forth in SEPA provide for a systematic, interdisciplinary approach to decisionmaking which might impact the environment. In addition, evaluations should ensure that environmental values will be given appropriate consideration along with economic and technical considerations. The PSDDA Phase II Management Plan is subject to SEPA.

1.2 Corps of Engineers 404(b)(1) Procedures and Policies.

1.2.1 Overview. Navigable waterways of the United States have and will continue to play a vital role in the nation's development. The Corps, in fulfilling its mission to maintain, improve, and extend these waterways, is responsible for the dredging and disposal of large volumes of sediment each year. Nationwide, the Corps dredges about 230 million cubic yards (c.y.) in maintenance and about 70 million c.y. in new dredging operations annually at a cost of about $450 million. In addition, 100-150 million c.y. of sediments dredged by others each year are subject to permits issued by the Corps. In accomplishing its national dredging and regulatory mission, the Corps has conducted extensive research and development in the field of dredged material management. Regulations, policies and technical guidance prepared and used by the Corps are based on operating experience and results from extensive research programs. Federal expenditures on dredged material research have cumulatively exceeded $100 million. Corps policy is evolving as dredged material research provides a better understanding of the environmental impacts that can be anticipated from dredging and dredged material disposal. Existing Corps national policy is reflected in the final rule for Corps operation and maintenance dredging of Federal navigation projects published April 26, 1988 (33 CFR Parts 209, 335, 336, 337, and 338) and in the final rule for the Corps' regulatory program published January 12, 1987 (33 CFR Parts 320-330).

The following discussion summarizes standard Corps policies with regard to the disposal of dredged material. These policies provide for the least costly alternative, consistent with sound engineering practices and appropriate environmental quality standards (see Management Plans Technical Appendix

(MPTA) for a more complete presentation of this policy). The details of the dredged material testing and test interpretation guidelines are included in an exhibit to the Evaluation Procedures Technical Appendix (EPTA).

1.2.2 Corps Authorities and Responsibilities. The Corps has regulatory responsibility for all dredged material disposal activities that occur within waters of the United States. The Corps responsibility involves review of some 10,000-30,000 permit applications each year as well as appropriate maintenance of, and improvements to, the 25,000 mile congressionally-authorized Federal navigation system serving 42 of the 50 states.

Section 404 of the CWA requires the Corps to evaluate the proposed discharge of dredged material into waters of the United States in accordance with the Section 404(b)(1) Guidelines. Requirements of other Federal laws may also apply.

1.2.3 Section 404(b)(1) Compliance. The Section 404(b)(1) Guidelines require compliance with several conditions prior to allowing disposal of dredged material in waters of the United States. Compliance requires the avoidance of "unacceptable adverse effects" to the aquatic environment. The Guidelines specify the following four conditions of compliance ("restrictions on discharge" per 40 CFR 230.10):

1. There is no other practicable alternative that would have less adverse impact on the aquatic environment.

2. The disposal will not result in violations of applicable water quality standards after consideration of dispersion and dilution (40 CFR 230.10(b)(1)), toxic effluent standards, or marine sanctuary requirements, nor will it jeopardize the continued existence of threatened or endangered species.

3. The disposal will not cause or contribute to significant degradation of the waters of the United States.

4. All appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic environment.

The findings of compliance with condition No. 3 are to be based, in part, on "evaluation and testing" of the proposed dredged material disposal on the aquatic environment (40 CFR 230.11). Per the Guidelines (40 CFR 230.61), specific evaluation procedures, including chemical and biological tests to determine compliance with the Guidelines and State water quality standards, are used by the Corps.

The Corps' final decision on any proposed dredged material disposal activity, however, must be based on a broad public interest review which not only considers information derived from chemical and biological tests, but which also considers an evaluation of the probable impact, including cumulative impacts of the proposed activity, on the public interest. In addition, embodied within this public interest review, is a Corps requirement to ensure

that the substantive concerns of over 30 Federal environmental laws, Executive Orders (EO's), etc., are properly addressed, whenever applicable. These include the CZMA, the Marine Protection, Research, and Sanctuaries Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, EO 11990 (Protection of Wetlands) and EO 11988 (Floodplain Management). While each of these Federal Statutes (including the CWA) is generally "resource specific" in regard to environmental protection, the Corps public interest review necessitates full consideration of all relevant information before rendering a decision. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposed activity will be considered.

The Corps' final decision will reflect the national concern for both protection and utilization of important resources. As such, the Corps is neither a proponent or opponent of dredging projects, but considers the merits of each on a case-by-case basis.

1.2.4 Corps Policy. The Corps, as agency policy, utilizes a standard philosophy and process in evaluating proposed dredged material disposal activities relative to the general public interest. This process is intended to meet environmental requirements at the least cost, within a consistent national framework. The standard provides a reference point for Corps field offices in addressing regional issues of dredged material management. Its intent is to ensure a necessary level of national consistency in the manner in which individual proposals for dredged material disposal are evaluated (e.g., testing procedures) and undertaken, while also ensuring a necessary level of flexibility by the Corps field offices to account for region-specific considerations. Significant deviations from national testing and evaluation guidance require consideration of cost, utility of information and full technical explanation and documentation in the Section 404(b)(1) evaluation.

For Corps operation and maintenance projects, it is the Corps responsibility, in developing dredged material disposal alternatives, to consider all facets of the dredging and disposal operation, including technically appropriate test and evaluation procedures, cost, engineering feasibility, overall environmental protection, and the "no dredging" option. The alternative selected by the Corps will be the least costly alternative, consistent with sound engineering and scientific practices, and meeting applicable Federal environmental statutes. This is viewed as the Corps' "Federal standard" (51 Fed. Reg. 19694).

The following paragraphs summarize the manner in which the Corps implements its national policies in evaluating permit proposals and Federal projects.

a. Permit Activities. The applicant for a Section 404 permit will receive guidance from the Corps as the permitting authority (40 CFR 230.61) concerning appropriate tests and evaluation procedures that will be applied to material proposed for dredging. This guidance will be in compliance with the Section 404(b)(1) Guidelines.

b. Corps Projects. For Corps projects, the Corps is required to use the Section 404(b)(1) Guidelines to determine the appropriate test and evaluation procedures for delineating the least costly, environmentally acceptable disposal alternative as well as to demonstrate compliance with applicable State water quality standards.

The Corps submits its findings concerning project compliance with the 404 Guidelines and State water quality standards to the State via the Public Notice process along with a request for Water Quality Certification. The certification request also includes relevant information to demonstrate compliance with applicable State water quality standards.

The Corps Public Notice and Finding of Compliance or Non-Compliance with the Section 404(b)(1) Guidelines, serves as a point of reference in any subsequent coordination with the State concerning additional requirements or conditions which the State may require for Water Quality Certification. The Corps' District Engineer has the necessary discretionary authority to develop additional evaluative information requested by the State. The legislative record for the CWA provides congressional recognition that Federal project costs may be increased in some instances to mitigate reasonable and technically appropriate State water quality concerns. However, if the District Engineer determines that a State's requirements are inappropriate, he may request that the State or project sponsor fund the additional costs associated with any such requirement. In such cases where the State or project sponsor agrees to fund the additional costs, the District Engineer must also determine and appropriately notify the State and project sponsor that such additional costs may affect the continued economic viability of the Corps project in question. In the event that the State or project sponsor does not agree to fund the additional cost, the District Engineer may defer dredging while determining if the dredging project is economically justified and is in the public interest.

This guidance serves as a consistent national framework and reference point for Corps field offices which must also address regional issues in dredged material management. In applying the process to different projects or regions of the country, it is necessary to detail specific testing procedures and adopt interpretation guidelines, as appropriate. Corps field office evaluations must be generally consistent with the national procedures, defensible in light of research results and scientific judgment, cost and time effective, and of direct use in Section 404 decisionmaking.

1.3 State of Washington Procedures and Policies on Dredging and Dredged Material Disposal.

1.3.1 Overview. In Washington, dredged material disposal is addressed by several programs at the State and local levels. These include State 401 Water Quality Certification, State water quality and dangerous waste laws, the State SMA and local shoreline management plans, State Hydraulics Project Approval, State proprietary management of State-owned aquatic lands, and by the Puget Sound Water Quality Managment Plan. The PSDDA plan treats these programs as a unified body of State policy.

1.3.2 Guidelines and Policies. The policies which cover the discharge of dredged material are the same as those for the discharge of any material into State waters. These policies are specified in the State of Washington Water Pollution Control Law RCW 90.48.020 and the Water Resources Act of 1971, RCW 90.54.020.

RCW 90.54.020 (3) reads, in part, "The quality of the natural environment shall be protected and, where possible, enhanced as follows:

(b) Waters of the state shall be of high quality. Regardless of the quality of the waters of the state, all wastes and other materials and substances proposed for entry into said waters shall be provided with all known, available, and reasonable methods of treatment prior to entry. Notwithstanding that standards of quality established for the waters of the state would not be violated, wastes and other materials and substances shall not be allowed to enter such waters which will reduce the existing quality thereof, except in those situations where it is clear that overriding considerations of the public interest will be served."

Current guidance and policies with regard to the evaluation of sediments to be dredged are embodied in the documents described below.

a. Guidelines for Issuing Water Quality Certifications for Dredging and Discharge of Dredged Material Department of Ecology, 82-13. This document describes minimum evaluation and testing procedures and guidance for overall project review.

b. Puget Sound Interim Sediment Criteria (PSISC) for Dredge Material, August 1985. The interim criteria were specifically developed for application in Puget Sound. The criteria established minimum chemical and biological sampling and analysis requirements. The criteria also established a numerical standard by which to make determinations on the suitability of dredged sediments for disposal in the unconfined, open-water disposal sites.

c. Protocol for the Use of Priority Pollutant Data to Determine Compliance with the Dangerous Waste Regulation. This protocol provides methodologies for evaluating data from chemical analysis of marine sediments to determine if additional testing under dangerous waste regulations is required. It is reserved to the professional judgment of the project reviewer to determine if the data indicates the guidelines should be applied to dredged sediments. However, it is the policy of the State that, if so warranted by the appropriate tests, marine sediments including dredged material can be classified as a dangerous or hazardous waste.

d. SMA Guidelines, WAC 173-16-060 (16) "Dredging." Local governments are to control dredging to minimize damage to existing ecological values and natural resources of both the area to be dredged and the area for deposit of dredged material. Identification of in-water disposal sites are to be identified cooperatively by local and State agencies. Local governments have adopted individual shoreline management plans and ordinances in support of

this policy. A model local shoreline management element has been proposed through PSDDA to provide consistency in how communities treat dredged material disposal (see exhibit B).

e. Puget Sound Water Quality Management Plan. In 1985 the State legislature established a Puget Sound Water Quality Authority (90.70 RCW) to develop, adopt, and oversee implementation of a Puget Sound Water Quality Plan. The plan has several objectives including:

(1) Long and short term goals and objectives for water quality management in the Sound.

(2) An analysis of laws, regulations, programs, and policies affecting water quality with recommendations for improving these.

(3) Better coordination of Federal, State, and local efforts affecting water quality.

According to statute, the plan is to address a broad range of pollution management issues which includes dredged material disposal. The final plan was adopted in December 1986 and implementation began in January 1987. For marine sediments the Authority directed Ecology to establish a classification system for sediments that cause observable adverse biological effects and to develop programs for management of dredging and dredged disposal. In October 1988 the PSWQA adopted a 1989 Puget Sound Water Quality Management Plan, which builds on the progress made in carrying out the first plan.

Implementation of the PSDDA management plans and designation of unconfined dredged material disposal sites are part of meeting the specific requirements of the legislation requiring adoption of the PSWQA plan (90.40 RCW). The 1989 PSWQA plan adopts by reference, key portions of the June 1988 PSDDA Phase I Management Plan.

1.3 Proprietary Regulation of Open-Water Disposal (WAC 332-30-166). This regulation establishes State policy on disposal site selection, proprietary use authorization, and use of disposal sites. These regulations are administered by DNR and will be updated to implement the PSDDA management plans.

1.4 Integration of Federal and State Roles. Section 404 of the CWA provides for specification of disposal sites and an evaluation of the material to be discharged at a specific disposal site. The manner in which the Federal guidelines are implemented is described in section 1.2 above.

The CWA also provides in Section 401 an opportunity for the State to evaluate discharges into State waters which are being permitted by a Federal agency. The primary method of evaluation is through an appropriate demonstration that the discharge will meet State Water Quality Standards. This State responsibility takes into account effects on the water body and toxic and deleterious effects on aquatic biota. For discharges of dredged material, the

State has taken the approach of evaluating dredged material to prevent the reintroduction of chemicals at levels which show indications of unacceptable adverse biological effects. Disposal sites in Puget Sound are selected through the procedures prescribed by DNR to avoid or minimize effects on important environmental resources.

The roles of State and Federal regulatory agencies in management of dredged material overlap in certain respects. For this reason, PSDDA agencies sought to develop a single dredged material evaluation and disposal site identification program which is consistent with both State and Federal requirements. However, there can be, and are, some differences in State objectives and Federal objectives for dredged material management regarding test procedures and data interpretation in determining the acceptability of dredged material for unconfined, open-water disposal. For example, State water quality objectives under State law can be different than under Federal law, and the Puget Sound Water Quality Plan contains specific sediment quality objectives for Puget Sound. Testing requirements need to be responsive to both Federal and State laws and objectives.

The PSDDA Phase I and Phase II plans, while recognizing differences between State and Federal objectives, nevertheless seek to maximize use of procedures and decision tools which meet objectives of both. The result is disposal site locations which are acceptable under both State and Federal authorities and dredged material evaluation procedures which have only minor technical differences between the State 401 and the Federal 404 approaches. These minor differences allow incorporation of testing needed to evaluate sediment toxicity questions while maintaining national consistency of Federal evaluation.

CHAPTER 2. BACKGROUND

2.1 Introduction. This chapter provides background to PSDDA including a description of the study area, issues and concerns which led to the study and study scope limitations. The relationship to other ongoing Puget Sound water quality planning efforts and Indian Fishing Treaty rights is reviewed. Finally, the study documents are identified and briefly described.

2.2 Study Area Description.

2.2.1 Geographic Divisions. As shown in figure 2.1, Puget Sound is one of three general bodies of water comprising the broader Puget Sound Region. Roughly separated from each other by shallow submerged ridges called sills, the three divisions consist of the Strait of Juan de Fuca, the Strait of Georgia, and Puget Sound proper, extending south from Admiralty Inlet near Port Townsend to Budd Inlet at Olympia.

The Puget Sound division can be further segmented into four basins: The central basin which lies between Admiralty Inlet and the Tacoma Narrows; the Whidbey basin between Whidbey Island and the eastern mainland; Hood Canal; and the southern basin which extends south of the Tacoma Narrows.

2.2.2 Phase II Area. This report and the accompanying final environmental impact statement (FEIS) present the study findings for the Phase II area of PSDDA as shown in figure 2.1. This area encompasses north and south Puget Sound, which includes the Olympia, Bellingham, Anacortes, Port Townsend, and Port Angeles harbors. The Phase I area (central Puget Sound) was the subject of a separate report and EIS (June 1988).

2.2.3 Physical Features. The Puget Sound Region was formed by global tectonic processes, giving rise to such major features as the Cascade and Olympic Mountains ranges which flank the basin to the east and west, respectively. However, the shape of the inland sea that now floods portions of this region is largely the result of more localized and relatively recent glaciation. Repeatedly during the last ice age, ice pushed southward from British Columbia through the Strait of Georgia and over the Puget Sound Region, the last such advance occurring about 10,000 years ago.

Puget Sound is an estuary where seawater from the Pacific Ocean mixes with freshwater from a large number of rivers. In some areas of the region, annual precipitation approaches 100 inches. The average annual flow of freshwater to the Sound is about 45,000 cubic feet per second.

The Whidbey basin accounts for most of the total freshwater discharged into Puget Sound. Over 60 percent of the Whidbey basin freshwater discharge is from the basin's largest rivers: the Skagit, Snohomish, and Stillaguamish Rivers. The central basin accounts for less than 20 percent of the total freshwater input to Puget Sound. The largest source for this basin is the Puyallup River, but significant flows are also received from the Green and

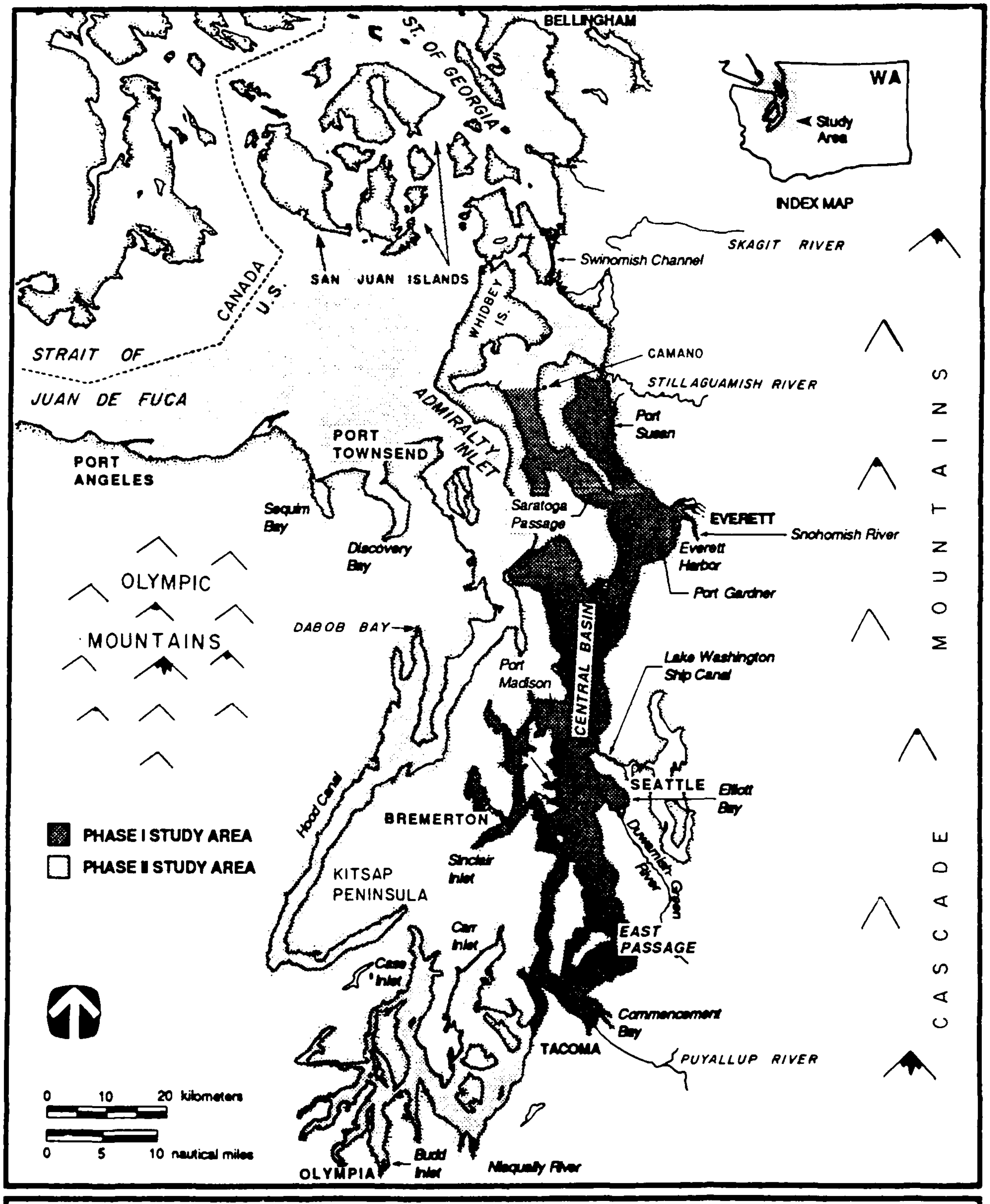


Figure 2.1 Study area -
Puget Sound Dredged Disposal Analysis

Duwamish Rivers. The principal river entering the southern basin is the Nisqually, contributing a little more than 10 percent of Puget Sound's freshwater input. Another 10 percent enters Puget Sound via Hood Canal through rivers draining the east slope of the Olympic Mountains and from small streams on the Kitsap Peninsula. Annually about 18 million c.y. of sediments are released into Puget Sound by the rivers and streams.

The unique diversity of Puget Sound waters, from deep, open water to saltwater and freshwater marshes, creates numerous productive habitats that support rich populations of shellfish, finfish, marine mammals, birds, and wildlife.

2.2.4 Social and Economic Features. The physical nature of the Puget Sound Region makes the region well suited for the harvest of natural resources and for water-dependent commerce and industry. The region's beauty and diversity attract recreation, too. Well over half of Washington's population lives in the Puget Sound Region, and about 2.2 million reside in the metropolitan corridor of Tacoma, Seattle, and Everett.

While harvesting natural resources has been and continues to be a major segment of the area's economy, service and high technology industries have grown in importance. Waterborne commerce and water-related industry also remain important factors in the economic well-being of the Puget Sound Region. According to the Puget Sound Water Quality Authority's (PSWQA) 1986 State of the Sound report, marine shipping alone may support as many as 100,000 jobs at this time. In the 30 years between 1953 and 1983, total annual tonnage of maritime shipping on Puget Sound more than doubled, to over 50 million tons. Most of this increase can be attributed to an expansion of international trade, representing a doubling of total tonnage since 1968. The PSWQA cites a forecast that suggests foreign cargo movements could increase from 26 million tons in 1983 to at least 40 million tons by the year 2000. In addition to shipping, more than 200 small boat harbors in the area meet the needs of commercial fishing vessels and pleasure craft.

2.3 Dredging and Dredged Material Disposal. Dredging is necessary to maintain waterways and harbors used for shipping and boat traffic, as well as for new port and marina construction. Beyond navigation improvement projects carried out by the Corps, Puget Sound ports, maritime industries, other Federal and State agencies, municipalities, and private companies also perform dredging and dredged material disposal. The continued need for dredging and the disposal of dredged materials is evident from Federal and State permit applications received monthly for such projects in navigable waters.

Since initial development of the cities and industries in Puget Sound, the volume and extent of dredging has grown proportionally with the development of waterborne commerce and recreational boating. Dredging and disposal of dredged material has been a common and longstanding practice, producing large volumes of dredged material each year. This includes new port and harbor construction and maintenance dredging. The latter ensures continued safe water depths for existing shipping channels and dock areas. Historically, most of the dredged material was deposited on uplands or in nearshore tidal

areas as fill for harbor developments. As areas near the dredging activity have been filled or have become unavailable due to land use conflicts, a greater portion of dredged material is being discharged into the Sound. Public policy, as reflected in recent regulatory decisions, has been to increasingly protect environmentally important tidal areas, wetlands, and marshes.

The Duwamish Waterway Project, in Seattle, is an example of the difficulty in securing acceptable upland disposal sites. One of the Corps' largest ongoing channel maintenance dredging projects, the Duwamish Waterway, changed from upland to open-water disposal in the 1970's. Open space in the urban and industrial environment of this waterway has, in the last 20 years, diminished to the point where nearby upland disposal sites are now largely nonexistent.

The lack of acceptable upland disposal sites in most urbanized areas is viewed by the ports and the regulatory agencies as a significant concern, which is being addressed by a separate follow-on study to PSDDA. That study is dealing with the need for public multiuser confined disposal sites (see paragraph 2.6.4).

As shown in table 2.1, of the 7.9 million c.y. dredged between 1970 and 1985 from the Phase II area, approximately 36 percent was discharged at eight DNR-operated unconfined, open-water disposal sites located in Admiralty Inlet, Bellingham Bay, Bellingham Channel, Padilla Bay, Skagit Bay, Dana Passage, Port Angeles and Steilacoom. These were public multiuser disposal sites requiring a DNR permit for their use. The balance of the dredged material was primarily used as a convenient source of fill for harbor development. Following implementation of the stringent Puget Sound Interim Criteria (PSIC), a significant percentage of material considered for unconfined, open-water disposal, was rejected for this disposal option. For the affected projects, dredgers were forced to find their own confined disposal site or not proceed with the dredging project.

Volumes dredged by the Corps, the ports, and others each represent about 26, 40, and 34 percent of the total during this period, respectively. Of this material, the Corps and the ports each placed about 70 percent of their dredged material in upland and nearshore sites, while other dredgers placed only 34 percent in upland and nearshore areas. These figures suggest that dredgers other than the Corps and ports have relied more heavily on unconfined, open-water disposal, perhaps due to fewer opportunities for land development projects. The Bellingham Channel site, located near Anacortes, was the most heavily used site, receiving approximately 39 percent of the total dredged material discharged at DNR designated Phase II area disposal sites.

The projected total volume to be dredged between 1985 and 2000 is 7,187,000 c.y., or about 9 percent less than the total dredged during the previous 15 years (see table 2.2). A 15-year planning horizon was used, as it encompasses all known major navigation projects and is a forecasting period that could be established with reasonable certainty. Most of the projected dredging could occur in six areas: Olympia Harbor, Swinomish Channel, Bellingham Bay, Fidalgo Bay, Lummi Bay, and Port Townsend. A significant portion of this dredging volume will be from channel maintenance by the Corps.

TABLE 2.1

PUGET SOUND DREDGED MATERIAL INVENTORY,
PHASE II AREA (NORTH AND SOUTH PUGET SOUND) 1970-1985
ALL VOLUMES ARE EXPRESSED IN CUBIC YARDS

A. Totals

Total Volume Dredged	7,900,000 c.y.
Total Volume Disposed to Unconfined, Open Water	3,253,000 c.y.
Total Volume Disposed at:	
•DNR Sites-North Sound	
Admiralty Inlet	165,000 c.y.
Bellingham Bay	766,000 c.y.
Bellingham Channel	1,147,000 c.y.
Padilla Bay	133,000 c.y.
Port Angeles	168,000 c.y.
Skagit Bay	173,000 c.y.
	2,552,000 c.y.
•DNR Sites-South Sound	
Dana Passage	141,000 c.y.
Steilacoom	235,000 c.y.
	376,000 c.y.
Other Open-Water Locations	325,000 c.y.

B. Project Type

	Corps of Engineers Projects	Port Projects	Other Projects
Total Volume Dredged (c.y.)	2,100,000	3,167,000	2,633,000
Total Volume Disposed to Unconfined, Open Water (c.y.)	615,000	901,000	1,737,000
Total Volume Disposed Upland or Nearshore (c.y.)	1,485,000	2,266,000	896,000

Approximately 1.5 million c.y. for Lummi Bay is associated with the proposed construction of the Lummi marina project which would not involve use of a PSDDA disposal site. However, this project has been included to present a total future dredging volume for comparison with historical dredging statistics. As the construction dredging volume will be used to construct a land base for shoreside facilities, this volume has been excluded from impact analysis associated with future discharges at the PSDDA disposal site. Future maintenance dredging for the Lummi Bay marina is, however, expected to result in the use of a PSDDA disposal site.

The costs of maintaining and constructing navigable waterways in Puget Sound waters have risen over time. Increased costs are due to a variety of factors, but two of the more important in Puget Sound are: (1) the rise in costs for dredging and disposal of dredged material and (2) costs for environmental evaluation of the material. An analysis presented in chapter 5 of the Phase I MPR and section 5 of the Phase I FEIS reveals how environmental testing costs and project costs have changed since 1974 in the Puget Sound region. The trend of average testing costs from 1974 to 1987 is illustrated in figure 2.2 for selected projects using the Elliott Bay Fourmile Rock disposal site for some or all of dredged material disposal. The costs presented here were not adjusted for inflation (e.g., normalized to a base year), but are reported as actual costs for the year in which they were incurred. Testing costs between 1974 and 1984 were very low, averaging less than $0.01 per c.y. of material dredged. Part of the reason for the low testing costs was the fact that while dredged material was an environmental issue in Puget Sound, the only problem area of concern was potential water column effects. Most of the testing undertaken was to assess the availability of chemicals of concern to the water column. However, the main reason for the low project-specific costs is that several large dredging studies were conducted during this time period in Grays Harbor, Commencement Bay, and elsewhere in the Nation which addressed many of the specific questions about dredging and water column effects. Findings from these studies were applied to all projects in the region, and reduced the need for project-specific testing and testing costs.

Following adoption of the Fourmile Rock Interim Criteria in 1984, project-specific environmental testing costs rose sharply, as shown in figure 2.2. By the time the Fourmile Rock criteria were developed, the focus of sediment evaluation had shifted from water column effects to potential effects related to the dredged material itself, particularly from chemicals that might be associated with the material to be disposed. The Fourmile Rock criteria required an intensive sampling scheme (one core for every 4,000 c.y.), and both chemical and biological testing. Material from two Seattle Harbor maintenance dredging projects were tested under the Fourmile Rock criteria. Environmental testing for these two projects resulted in costs of $0.28 per c.y. (upper turning basin) in 1986 and $0.75 per c.y. (West Waterway) in 1987 (figure 2.2).

TABLE 2.2

PHASE II AREA

TOTAL PROJECTED DREDGING VOLUMES (CY)

15 YR PROJECTIONS (1985-2000)

Source of Dredging	South Sound	North Sound	Total
Corps 1/	500,000	2,370,000	2,870,000
Ports 2/	225,000	1,459,000	1,684,000
Other (Private, Municipal, DOT) 3/	612,000	2,021,000	2,633,000
TOTAL	1,337,000	5,850,000	7,187,000

1/Forcast by Corps for existing and proposed Federal navigation projects.
2/Forecasts by Puget Sound Port Districts.
3/Assumed to be equal to permitted dredging volumes over period 1970-1985.

TABLE 2.3

NORTH SOUND (1)
PROJECTED DREDGING VOLUMES (CY)
BY SPECIFIC DREDGING AREAS WITHIN THE NORTH SOUND STUDY AREA
15 YR PROJECTIONS (1985-2000)

Dredging Site	Projected Volumes			
	Total	Corps	Ports	Other
Swinomish Channel (2)	1,179,000	400,000	123,000	656,000
Bellingham bay	756,000	360,000	365,000	31,000
Blaine	350,000		350,000	
Fidalgo Bay (3)	768,000	60,000	140,000	568,000
Lummi Bay (4)	1,553,000	1,550,000		3,000
San Juan Islands (5)	165,000			165,000
Port Angeles (6)	285,000		104,000	181,000
Port Townsend	422,000		377,000	45,000
Admiralty Inlet (7)	121,000			121,000
Whidbey Island (8)	107,000			107,000
Hood Canal (9)	144,000			144,000
TOTAL	5,850,000	2,370,000	1,459,000	2,021,000

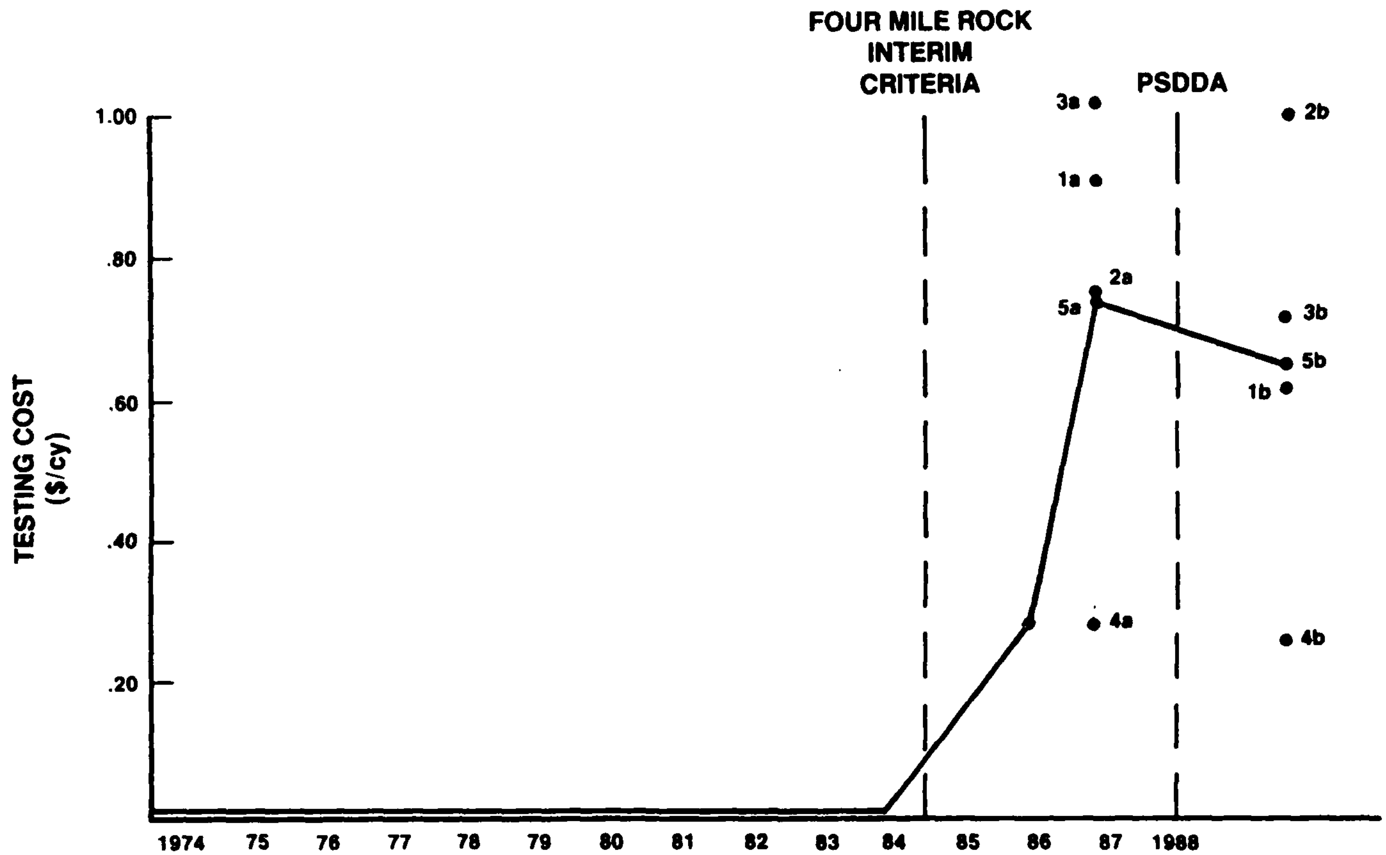
(1) North Sound study area includes all Puget Sound study area waters and shoreline north and west of the Phase I study area to Port Angeles. Waters involved in the PSDDA study do not extend west of Port Angeles.
(2) Swinomish Channel dredging area includes the Swinomish Channel and Skagit Bay.
(3) Fidalgo Bay dredging area includes Fidalgo bay, Anacortes, and Padilla Bay.
(4) Lummi Bay dredging area includes Lummi Bay and Lummi Island.
(5) San Juan Islands dredging area includes Orcas, Shaw, Lopez and San Juan Island.
(6) Port Angeles dredging area includes Port Angeles, and Sequim Bay.
(7) Admiralty Inlet dredging area includes Keystone Harbor and other dredging areas along Admiralty Inlet.
(8) Whidbey Island dredging area includes Cresent Harbor, Oak Harbor, and other eastern side of Whidby Island north of the Phase I study area.
(9) Hood Canal dredging area includes all of Hood Canal and Port Gamble.

TABLE 2.4

SOUTH SOUND (1)
PROJECTED DREDGING VOLUMES (CY)
BY SPECIFIC DREDGING AREAS WITHIN THE SOUTH SOUND STUDY AREA
15 YR PROJECTIONS (1985-2000)

Dredging Site	Projected Volumes			
	Total	Corps	Ports	Other
Olympia/Budd Inlet	1,037,000	500,000	225,000	312,000
Tacoma Narrows (2)	86,000			86,000
Shelton/Oakland Bay	67,000			67,000
Pickering Pass (3)	104,000			104,000
Steilacoom (4)	43,000			43,000
TOTAL	1,337,000	500,000	225,000	612,000

(1) South Sound study area includes all Puget Sound waters and shoreline south of the Tacoma Narrows Bridge.
(2) Tacoma Narrows dredging area includes The Narrows south of the bridge, Hale Passage, Henderson Bay, and Carr Inlet.
(3) Pickering Pass dredging area includes Pickering Pass, Peale Pass, Case Inlet, and Henderson Inlet.
(4) Steilacoom dredging area includes Steilacoom and Nisqually Reach.



a: Actual testing costs b: Testing costs under PSDDA;

1a,b: Kenmore Navigation O&M.

2a,b: Seattle Harbor O&M West Waterway.

3a,b: Port of Seattle, Terminal 30.

4a,b: Seattle Harbor O&M Upper Turning Basin.

5a,b: Average costs based on total testing costs/total cy for all four case studies.

Figure 2.2. Historical trend — dredged material testing costs.

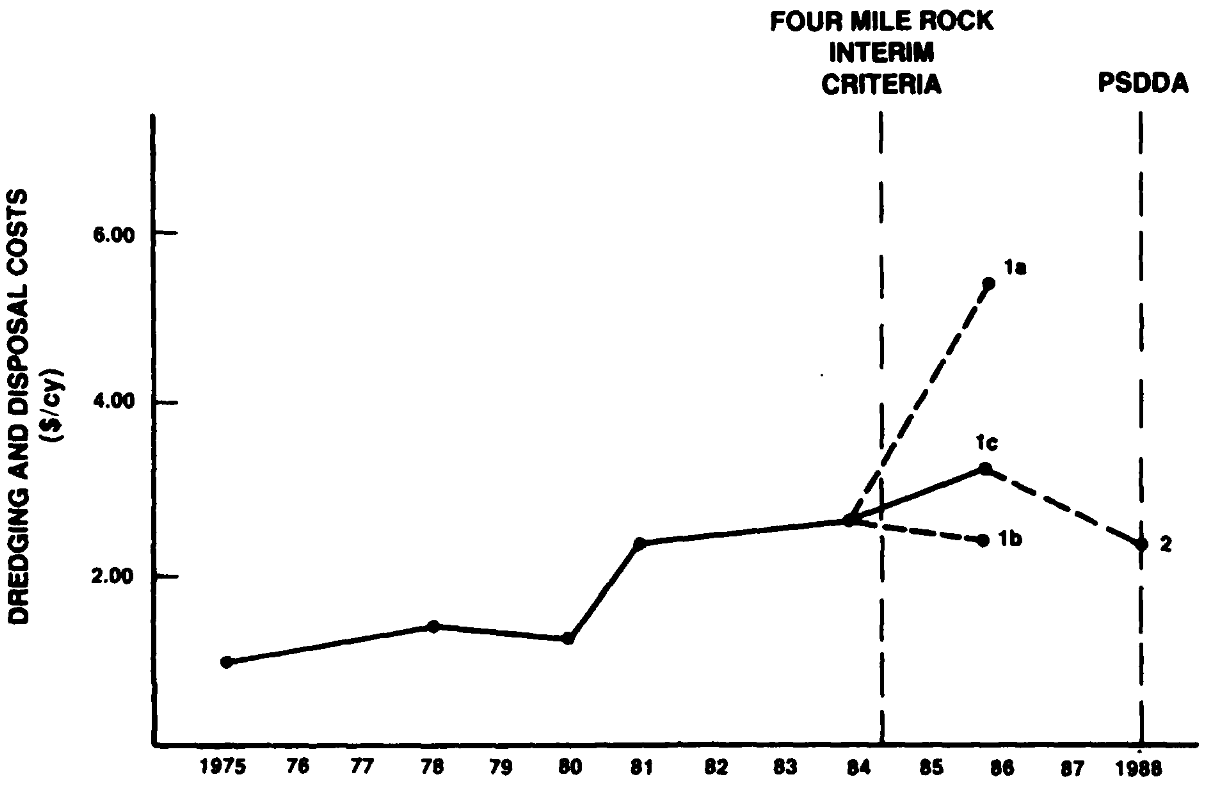
Several case studies were considered in order to estimate the costs of conducting testing under PSDDA (for details, see Phase I MPR chapter 5). The projects selected were all from the Seattle area and included three projects from the Duwamish River. The case studies indicate that PSDDA could result in a change in testing costs relative to costs associated with testing under the Fourmile Rock criteria. Testing costs under PSDDA were estimated from the case studies to range from a high of $1.00 per c.y. to a low of $0.26 per c.y. When compared with actual costs for the case study projects, PSDDA testing costs ranged from an increase up to 34 percent or a decrease by as much as 32 percent, depending on project-specific attributes.

Through February 1989 five dredging projects had been evaluated using the PSDDA dredged material evaluation procedures. The sampling and testing costs averaged, on a per project basis, about $0.60 per c.y. (unit costs varied from $0.10 to $1.75 per c.y.). The projects ranged in size from 7,000 c.y. to 535,000 c.y. and were located in both high and low concern areas. Some projects were subject to both chemical and biological testing, while others only required chemical testing.

As with testing, cost data on dredging and disposal from the Seattle Harbor (Duwamish River) maintenance project were used to determine trends in these costs for the Puget Sound region. Costs associated with dredging and disposal are illustrated in figure 2.3. Average dredging and disposal costs have generally risen since 1975, going from about $1.00 per c.y. dredged to over $3.00/c.y. This increase in costs reflects a number of factors, including inflation, a large increase for equipment, manpower, and fuel costs, and lack of available disposal sites. The trend under PSDDA should be to lower dredging and disposal costs over those experienced from use of the interim criteria (Fourmile Rock, Port Gardner, PSIC). This is because more material is expected to be found suitable for unconfined, open-water disposal. However, the costs under PSDDA will exceed those experienced prior to the interim criteria.

2.4 Issues/Concerns Leading to Study.

2.4.1 Water Quality Issues. The perception of Puget Sound as a relatively pristine water body has undergone reconsideration in the years since 1978. The historic practice of discharging untreated or only partially treated industrial and municipal effluent into Puget Sound, combined with input of chemicals from a variety of other point and nonpoint sources, resulted in the degradation, over time, of the water and sediment quality in portions of Puget Sound. Increasing scientific evidence about the harmful effects of pollution on the estuary has served to heighten public and agency concern about the long term environmental health of the estuary and the impact that various activities can have on the Sound's ecosystem. Research conducted by NOAA indicates that tumors and other biological abnormalities found in some fish and shellfish, especially in the urban/industrial areas near Tacoma, Seattle, and Everett, may be linked to the chemicals in harbor sediments.



1a,b,c: Dredging and disposal costs for one project (actual). 1a: Material costing $5.68/cy represents costs of confined nearshore disposal. 1b: Represents costs for material that went to *unconfined* open-water. 1c: Represents average cost/cy for the project.

2: *Average cost of dredging and disposal for project shown under 1a,b,c, but evaluated under PSDDA guidelines.* All material estimated to be acceptable for open-water disposal.

Figure 2.3. Historical trend — dredging and disposal costs — Seattle Harbor (Duwamish River).

Recent and ongoing efforts to improve regulatory control of chemicals at their source have resulted in general improvements in water quality. Concerns remain, however, that because chemicals tend to bind to the particles and settle to the bottom, the sediments in certain portions of the Sound may persistently contain high levels of potentially harmful chemicals. Data indicate that chemicals that have entered the major harbor areas near population and industrial centers, have accumulated over time in a variety of shoreline areas including navigation channels and vessel berthing locations. Furthermore, oceanographers estimate that 60 to 80 percent of the water flowing out of the central and south Sound on outgoing tides is recycled back into the system. Most chemicals released into the Sound appear to never leave and generally accumulate in the bottom sediments.

The fact that chemicals are often found in the bottom sediments of shipping waterways has raised concerns about disposal of dredged materials removed from waterways. These concerns have prompted agencies and the public to reassess dredged material disposal, which can involve the relocation of sediment-bound chemicals from a navigation channel to the disposal site.

Because information on Puget Sound disposal sites was inadequate and impacts not well documented, public pressure was exerted in 1984 and 1985 to severely restrict or to prohibit dredged material disposal in Puget Sound. Through the State of Washington SMA, several local governments imposed stringent conditions on renewal of shoreline development permits governing unconfined, open-water disposal at public multiuser sites located within their jurisdictions. These permits are obtained by DNR, which in turn make DNR and Ecology accountable for ensuring that dredged material does not cause unacceptable adverse effects.

PSDDA study has focused on unconfined, open-water disposal of dredged material, an activity that must consider the potential presence and effects of sediments containing chemicals of concern. To place this activity in some perspective, periodic dredging by the Corps of Engineers of Federal navigation projects and dredging by others of Federal and non-Federal projects occurs in an estimated 0.08 percent or less than 2 square miles of the total 2,500 square mile surface area of Puget Sound. In the 1970-1985 period, about 9 million c.y. or approximately 36 percent of the 24.8 million c.y. of material dredged was disposed at designated unconfined, open-water disposal sites located within the Sound (Phase I and II areas).[1/] This can be compared to the 250-300 million c.y. of sediment that were discharged by the rivers flowing into Puget Sound over this same period.

2.4.2 Dredged Material Disposal. In the State of Washington, major actions affecting marine waters, including dredging and disposal activities, require (at the minimum) coordination with and review by four Federal agencies (Corps, EPA, Fish and Wildlife Service (FWS), and National Marine Fisheries Service

1/The Phase II area contributed 7.9 million c.y. or about one-third of the total material dredged in Puget Sound during this period (see table 2.1).

(NMFS)) and four State agencies (Ecology, DNR, Department of Fisheries (WDF) and Department of Wildlife (WDW)). Local county or municipal governments are involved through the State Shoreline Master Program.

Applicants for permits require approvals from the Corps under Section 404 of the CWA, and Ecology under Section 401, "Water Quality Certification." CZMA consistency. administered through city and county implementation requirements of the State CZM program with review and approval by Ecology, is also required. DNR coordinates disposal site selection and issues approvals to individual projects for site use. A Hydraulics Project Approval is also required for disposal from the WDF and WDW.

Disposal of dredged material into open water has been a common, long standing practice throughout the State. Until 1970, open-water disposal occurred with minimal regulation regarding location, quantity, or quality. In the early 1970's, DNR created the Interagency Open Water Disposal Site Evaluation Committee (Interagency Committee) to "advise" DNR in developing guidelines for selection of disposal sites in State waters and in the selection of "approved" sites. Federal participation in this Interagency Committee was a result of informal policy rather than specific requirement or agreement. The Corps was represented at meetings of the Interagency Committee and generally cooperated with the "advisory" recommendations of the committee. Use of these approved sites has been the convention: projects that did not use the approved sites typically faced greater scrutiny and were less likely to be permitted by the State and, hence, the Federal Government.

The Corps, EPA, and Ecology traditionally have determined the technical suitability of the material to be discharged through their water quality authorities and expertise, relying on the Corps public notice procedure for notification of an activity and to obtain public and other agency review. DNR has relied on EPA, the Corps, and Ecology to assure that dredged material placed at DNR sites would not produce unacceptable adverse effects. In the past the Corps developed and implemented (in cooperation with Ecology and EPA) testing procedures for its navigation projects to determine the acceptability of dredged material for open-water disposal. Similar procedures were required of permit applicants. Such testing was typically requested of applicants by EPA with informal coordination with Corps specialists.

Ecology developed its 401 certification program during the mid- to late-1970's under the authority of the CWA and ultimately assumed a joint lead role with EPA and the Corps on testing and evaluation requirements associated with permit applications. In 1977 and 1978, Ecology in cooperation with other State and Federal agencies developed water quality controls (regulations implemented pursuant to their 401 certification authority) for dredging and disposal activities in Grays Harbor, as part of the Corps' Long Range Maintenance Dredging Program for that estuary. These regulations were formalized and issued as "Water Quality Guidelines for Dredging in Inner Grays Harbor and Lower Chehalis River," and became a modification of State water quality standards. Use of these guidelines were reflected in Corps permit decisions as State or EPA comments on the activity. Many of the requirements and evaluations specified for Grays Harbor were informally applied to other State waters (e.g., Puget Sound) by Ecology and EPA in their permit reviews.

By the 1980's it was accepted that it was necessary to meet EPA and Ecology water quality requirements (through water quality testing or monitoring, compliance with established EPA water quality criteria, and State water quality standards, etc.). For its own projects, the Corps continued to be responsible for testing and evaluation of water quality concerns (including sediment quality). Due to the number of Corps projects and the need to coordinate with EPA and Ecology, considerable exchanges of data and expert knowledge occurred. Frequently, the results of Corps studies were used to refine EPA and Ecology testing requirements and decisionmaking. A beneficial outcome of this cooperation was the realization that the traditional definition of "water quality concerns" needed to be expanded to include consideration of potential sediment effects.

The mounting evidence in the early 1980's of pollution problems in Puget Sound focused attention on the sediments containing chemicals of concern in the urban/industrial harbors and navigation channels. Although the sediments contained these chemicals as a result of inadequate point and nonpoint pollution control, the public perceived the continuing practice of open-water disposal of material dredged from industrialized waterways to be a possible source of pollution in and of itself. Evidence that sediment chemistry was elevated above other areas at the Fourmile Rock disposal site in Elliott Bay was highlighted in the extensive media coverage of Puget Sound water quality issues that took place in 1984. Because no environmental monitoring had been performed at the existing disposal sites, there was little actual field data with which to respond to this concern. Also, agency agreement was lacking on the validity of the concern. Accordingly, public pressure was exerted to severely restrict or prohibit dredged material disposal in Puget Sound. Traditional water quality evaluation procedures alone were no longer considered sufficient for assessing the potential for pollution-related impacts at the disposal sites. Development of management techniques to address dredging and disposal concerns were just being initiated and local governments were responding to the concerns of their constituents by imposing stringent conditions on renewals of open-water site permits. Since these disposal sites could not be used without a local shoreline management permit, the impact on dredging and disposal was immediate. The two most used disposal sites, Fourmile Rock in Elliott Bay and the Port Gardner site near Everett, were closed in 1984. Fourmile Rock was reopened in 1985 and closed again on June 7, 1987.

At the request of the city of Seattle, EPA Region X developed interim criteria for use of the Fourmile Rock disposal site in 1984. In 1985, Ecology developed interim criteria for the Port Gardner disposal site, in response to a request from the city of Everett. These criteria, while never formally "adopted" by EPA or Ecology, were used by those agencies to evaluate projects proposing disposal in Elliott Bay and Port Gardner. The Corps participated in a technical advisory capacity during development of the criteria. While the Corps did not formally concur with the criteria, the criteria were considered by the Corps on a case-by-case basis.

The interim criteria for the Fourmile Rock site were formalized as a condition of the shoreline management permit issued by the city of Seattle to DNR for use of the site. These criteria were based on a "nondegradation" policy (see chapter 5) and were envisioned as temporary measures, until regionally acceptable guidelines could be developed. Reports by EPA and the PSWQA prepared in 1984, called for a regional study of dredging and dredged material disposal. In August 1985, the State adopted interim criteria for the remainder of Puget Sound that were based upon the interim criteria drafted for the Port Gardner disposal site. Since the mid-1980's, and until 1988, the Fourmile Rock, Port Gardner, and PSIC were used by EPA and Ecology to determine acceptability of dredged material for open-water disposal. Following completion of the Phase I FEIS in June 1988, the PSDDA agencies began applying the PSDDA dredged material evaluation procedures to dredging projects proposed for the Phase I area.

2.4.3 Establishment of PSDDA. The need for dredging coupled with the following problems led to PSDDA:

• Recognition that all three of the existing DNR disposal sites in Central Puget Sound could be closed by June 1988. Two of the sites were closed when the study began. While one of the sites reopened, it closed again in June 1987 when the local shoreline permit expired.

• Uncertainty with regard to proper disposal site locations. Objections were raised about the proximity of the existing Port Gardner and Fourmile Rock disposal sites to residential, public recreational, and valuable aquatic resource areas.

• Lack of consistently applied dredged material evaluation procedures. While the Section 404(b)(1) Guidelines have provided guidance and direction for Puget Sound dredged material evaluation, they have not been interpreted and applied on a consistent basis by the various regulatory agencies.

• Lack of disposal site management plans. No overall disposal site management policy has existed in the past, with few site-use compliance inspections and limited environmental monitoring of site conditions performed. The lack of monitoring has contributed to public concerns about the discharge of dredged materials. Without monitoring data it is difficult to determine actual disposal effects.

In August 1984, the Regional Administrator for EPA Region X asked the Corps, Seattle District to undertake the lead in a Sound-wide, programmatic EIS on dredged material disposal. The request was supported by the Governor of the State of Washington, the Director of Ecology, the Commissioner of Public Lands for DNR, and many others, including the PSWQA, in the form of letters and personal contacts.

In December 1984, the Corps, EPA, Ecology, and DNR began a period of intensive technical discussions to develop a joint study plan. The culmination of these efforts is the PSDDA Plan of Study, agreed to by the agencies in March 1985, which established the basis for this cooperative effort.

2.5 Study Limitations. The PSDDA Federal and State agencies have identified disposal sites and site management plans only for unconfined, open-water disposal. Locations for conventional upland/nearshore sites and confined disposal sites (confined aquatic or upland/nearshore) have not been specified. There are several reasons for this. First, disposal in Puget Sound waters principally involves Federal and State authorities while disposal on land (especially for contaminated material) is very much associated with local government decisions regarding land uses. And second, the State of Washington, in a study initiated in 1988, is addressing confined disposal options and associated testing procedures, building on the work done through PSDDA. This confined disposal study is an element of the PSWQA's Comprehensive Water Quality Management Plan (see paragraph 2.6.4).

An evaluation comparing the potential impact of dredged material disposal to the impacts of other water-related activities in Puget Sound is also beyond the scope of this study. However, due to the limited areas to be dredged and the conditions imposed by regulatory agencies, dredged material disposal at unconfined, open-water sites has very little potential for affecting the overall ecosystem of Puget Sound. This conclusion is supported by information derived from the PSDDA study and presented in study documents.

Dredged material disposal costs associated with confined disposal options were assessed on a programmatic basis for purposes of the PSDDA Phase I alternatives analysis (see Phase I FEIS). This was done to estimate economic impacts associated with different biological effects conditions considered for unconfined, open-water disposal site management. In some instances, material deemed unsuitable for open-water disposal must be confined if the project is to be undertaken. As confined disposal can be 3 to 10 times more expensive, some projects may not be economically feasible if required to use confined disposal, and will not be dredged. For Federal maintenance projects the Corps may not dredge if economically and environmentally acceptable disposal sites are not available. Any significant increase in costs due to new dredged material management requirements e.g., testing, monitoring, etc. could result in marginal projects being held in abeyance.

Not addressed, or precluded by PSDDA, are possible beneficial uses of dredged material such as habitat development, parks and recreation, capping of problem sediments, shoreline erosion control, or use as construction fill. Obviously a significant amount of the dredged material found suitable for unconfined, open-water disposal could be put to beneficial use. The reader is referred to the U.S. Army Corps of Engineers Manual EM 1110-2-5026, "Beneficial Use of Dredged Material", for information on beneficial uses.

Also, material that may be dredged solely for the purposes of contamination cleanup, e.g., Superfund program actions, was not addressed in the PSDDA study due, in part, to an assumption that the sediments to be removed by cleanup programs would not be acceptable for unconfined, open-water disposal in Puget Sound (see paragraph 2.6.3). However, in general, all dredged material found suitable for disposal at a PSDDA site is likely to be allowed at that site.

2.6 Relationship to Other Studies/Regulatory Programs.

2.6.1 Puget Sound Estuary Program. PSDDA was initiated as a related, but separate, element of the Puget Sound Estuary Program (PSEP) which began in 1984. Administered jointly by the EPA and Ecology, PSEP has had two primary purposes:

- Identification of water quality problems.

- Promotion of cleanup actions through EPA/Ecology programs, as well as efforts by others.

PSEP is working to increase basic understanding of the complex Puget Sound estuarine ecosystem and to separate real from perceived environmental problems. Resources are being focused on the significant problem areas. Source control and action plans for major urban embayments have been identified as meriting priority attention. The activities of PSEP are being coordinated through the PSEP Management Committee that is co-chaired by EPA, Ecology, and PSWQA. Since the establishment of PSWQA, the PSEP program has gradually been integrated to the overall effort to implement the PSWQA plan (see paragraph 2.6.2). A number of common interest technical activities were jointly funded through PSEP and PSDDA.

2.6.2 Puget Sound Water Quality Authority (PSWQA). In addition to the PSEP program, PSDDA has been closely coordinated with the PSWQA. In May 1985, the PSWQA was directed by the State legislature to prepare a comprehensive Sound-wide cleanup plan. A plan, adopted by PSWQA in December 1986, proposes various actions to control and prevent pollution Sound-wide. According to legislative mandate, the plan contains recommendations addressing a variety of pollution related issues including nonpoint source pollution management, industrial pretreatment of toxic wastes, dredged material disposal management, and the protection, preservation, and restoration of wetlands, wildlife habitat, and shellfish beds. (For detailed information about comprehensive pollution control efforts, see the 1987 Puget Sound Water Quality Management Plan (PSWQA, January 1987) and the Final Environmental Impact Statement and Revised Preferred Plan (PSQWA, December 1986). Also see the 1989 Puget Sound Water Quality Management Plant (PSWQA, October 1988) for an update of programs identified in the 1987 plan and a discussion of issues that could not be addressed in the 1987 plan.

A key issue addressed by the PSWQA in their Puget Sound Water Quality Management Plan is the evaluation of dredging and disposal of dredged material containing chemicals of concern. The plan presents a preferred strategy with alternative programs. PSDDA is acknowledged by PSWQA as the appropriate means for dealing with unconfined, open-water disposal of dredged material. PSWQA incorporated the PSDDA Phase I area plan into the 1989 PSWQA Water Quality Management plan following the completion of the final PSDDA EIS. The PSDDA Phase II area plan is expected to be similarly adopted by PSWQA. (Also see chapter 3 for further discussion of PSWQA and its adopted policies for dredged material management.)

2.6.3 Commencement Bay - Superfund. In support of Ecology's Commencement Bay studies and cleanup activities at the nearshore/tidal flats Superfund site, the Corps' Waterways Experiment Station developed a decisionmaking framework for determining what materials are acceptable for various types of disposal. The decisionmaking framework considers potential contamination problems in the deepwater, intertidal, and upland areas. The Commencement Bay effort provided a useful model from which to develop dredged material evaluation procedures for PSDDA.

See paragraph 2.5 regarding the separation of dredging and disposal activities required as Superfund actions from the normal navigation dependent dredging and disposal activities that are addressed by the PSDDA study.

2.6.4 Multiuser Confined Disposal. PSWQA has mandated that Ecology undertake a feasibility study of multiuser confined disposal sites as a necessary complement to the PSDDA study. The Ecology effort, which began in 1988, will build on the work done by PSDDA.

2.7 Applicability to Other Areas. While the PSDDA plans are consistent with all applicable Federal laws they are unique to the Puget Sound area because the data base used in establishing the plans are derived from Puget Sound sediments and marine organisms. Also, the public expressions considered in making decisions on the alternatives are reflective of this region's social values. Another aspect by which the region differs with all other regions of the Nation is the role that local governments play in dredged material disposal. Through the State of Washington shoreline master program shoreline permit process, local jurisdictions can condition or restrict dredging and dredged material disposal.

2.8 Indian Fishing Treaty Rights. Because dredging and the open-water disposal of dredged material takes place in waters where there are Indian commercial fishing activities, Indian Fishing Treaty Rights have been given special attention by the PSDDA agencies. There are 14 Puget Sound treaty tribes that are recognized as sovereign tribal entities with fishing rights at all "usual and accustomed grounds and stations" in Puget Sound and the Strait of Juan de Fuca (as defined in United States v. Washington [384 F. Supp. 312], known as the Phase I Boldt Decision).

Among those fishing rights protected by treaty is an unrestricted right to Indian fishing activities within reservation boundaries and a "right in common" to harvest the fisheries resources in "usual and accustomed" fishing areas historically used by Indian tribes.

In U.S. v. Washington, the treaties were interpreted to grant treaty tribes a right to harvest a share of each run of anadromous fish that passes through tribal fishing areas, including salmon and steelhead. Included within the treaties are rights to harvest for ceremonial and subsistence purposes within these areas.

The following tribes possess adjudicated fishing rights in or around the alternative disposal sites studied by PSDDA in north and South Puget Sound:

Nisqually Tribe
Squaxin Island Tribe
Jamestown Tribe
Port Gamble Klallam
Lower Elwha Klallam
Swinomish Tribe
Suquamish Tribe
Tulalip Tirbes
Puyallap Tribe
Lummi Tribe
Nooksack Tribe

The following tribes are not formally recognized by the Federal Government at this time for the purpose of receiving services from the U.S. Bureau of Indian Affairs, though may additionally possess fishing rights to be recognized in the future:

Samish Tribe (area unknown)
Skykomish Tribe (area unknown)
Snohomish Tribe (area unknown)
Snoqualmie Tribe (area unknown)
Stillicum Tribe (area unknown)

In general, commercial fishing activity of the Indian tribes is concentrated from July through January of each year, with target species varying during this period. Typically fishing begins in the summer with chinook salmon and ends in winter with steelhead. The bulk of the commercial catch value is usually associated with the coho salmon fishery, which peaks in late summer and early fall. Specific fishery efforts in the Phase II areas of disposal activity are described in the FEIS as is the treatment of Indian treaty fishing concerns.

Indian treaty fishing rights have been fully taken into account in the development of the PSDDA plan (see FEIS section 2.04). To ensure tribal input, coordination was maintained throughout the PSDDA study with Indian tribes. Participation in work group meetings, direct contacts with individual tribes, and special meetings with tribal representatives, as well as exchange of correspondence, were used to identify tribal concerns that were addressed by the study team as reflected in the study documents.

2.9 Study Documents. The primary PSDDA Phase II study documents include a report containing the management plan, a technical appendix which provides detailed information in support of the management plan, and a FEIS focusing on the alternative disposal sites considered for the Phase II area.

- Management Plan Report - Unconfined, Open-Water Disposal of Dredged Material, Phase II (North and South Puget Sound). This document describes the study background, goal, objectives, and planning process which

resulted in the PSDDA management plan. The plan is presented with expanded coverage given to major program elements. Also included is a discussion on plan implementation.

- Disposal Site Selection Technical Appendix - Phase II (North and South Puget Sound). A detailed description of the disposal site identification process for future dredged material disposal is provided along with information on the existing disposal site and alternative sites considered.

- Final Environmental Impact Statement (NEPA/SEPA) - Unconfined, Open-Water Disposal Sites for Dredged Material, Phase II, (North and South Puget Sound). This document presents and evaluates the selected Phase II area, unconfined, open-water disposal sites, and alternative sites considered.

CHAPTER 3. STUDY GOAL, OBJECTIVES, PLANNING PROCESS, AND MANAGEMENT PLAN

3.1 Goal. The goal of PSDDA was to provide publicly acceptable guidelines governing environmentally safe unconfined, open-water disposal of dredged material, thereby improving consistency and predictability in dredged material management. Public acceptability involves consideration of a wide range of factors. Among these are scientifically sound procedures and practicability, which includes cost effectiveness, and the extent and permanence of beneficial and/or detrimental effects. PSDDA, while specific to the Puget Sound region, is intended to be responsive to the CWA goal to "restore and maintain" the integrity of the aquatic environment and be complementary and in compliance with Section 404(b)(1) Guidelines.

3.2 Objectives. The objectives of PSDDA were as follows:

a. Identify acceptable, unconfined, open-water disposal sites.

b. Define consistent and objective evaluation procedures for dredged material to be placed at those sites.

c. Formulate disposal site management plans that will ensure adequate controls and public accountability.

The first objective involves locating disposal sites in Puget Sound that are both environmentally acceptable and economically feasible for unconfined, open-water disposal. The second objective seeks to establish a basis for disposal decisionmaking that is scientifically sound and consistent. This includes chemical and biological testing requirements for dredged materials and establishing guidelines that allow a determination to be made on the suitability of material for disposal in Puget Sound waters.

Data generated in accomplishing the first two objectives contributes to the third objective: developing a management plan for each of the open-water disposal sites. The site management plans define the roles of local, State, and Federal agencies, and address such matters as permit reviews, monitoring of permit compliance, treatment of permit violations, disposal site use restrictions, monitoring of environmental impacts, responding to unforeseen site disposal effects, plan updating, and data management.

3.3 Planning Process. The PSDDA planning process generally followed the Plan of Study (POS) adopted by the Corps, EPA, DNR, and Ecology in March 1985. The study goal, objectives, scope of effort, organization structure, tentative work plan, and budgets are contained in the POS. Also key agency understandings are set forth in the POS regarding the basis of participation in PSDDA. The public, other Federal and State agencies, local governments, Indian tribes, and various interests were given an opportunity to comment and influence the scope of the study through responses to a public meeting notice and a notice of intent to prepare an EIS that were issued in April 1985. Study organization and coordination/public involvement are further described below.

3.3.1 Organization. The organizational structure of PSDDA consisted of four key control elements as shown in figure 3.1. These were the Policy Review Committee (PRC), Technical Steering Committee (TSC), three Technical Work Groups, and a Study Director.

The PRC was chaired by the District Engineer of the Seattle District, Corps, and included the Regional Administrator of EPA, Region X, the Director of Ecology, and the Commissioner of Public Lands for DNR. This committee periodically met with the Study Director to review study progress and deal with major policy issues.

The TSC provided oversight of the study, giving close review of progress and products. It also acted as a liaison with the PSEP Management Committee. During the major work activities of Phase I of PSDDA, the TSC met nearly monthly with the Study Director.

Three technical work groups, corresponding to each of the three study objectives, had responsibility for the technical studies and analysis leading to the PSDDA findings and program elements. These included: the Disposal Site Work Group (DSWG), the Evaluation Procedures Work Group (EPWG), and the Management Plan Work Group (MPWG). All four of the principal agencies served on the work groups. The Corps chaired the DSWG and the EPWG, and DNR chaired the MPWG. Representatives of other State and Federal agencies, Corps professionals from other than the Seattle District office, Puget Sound ports, Indian tribes, environmental organizations, and private citizens also provided important contributions during work group sessions, which were conducted nearly monthly during the first year of the study. A number of consulting firms and Federal research laboratories also participated in the study through contractual arrangements/agreements.

The Study Director, the fourth element in the PSDDA organization, interfaced with the PRC, TSC, and the work groups in carrying out overall management responsibilities. The Study Director and the work groups constituted the study team.

The Corps shared with DNR the lead responsibility for preparing the Phase II EIS to ensure compliance with both Federal and State regulations. EPA is a cooperating Federal agency and Ecology a cooperating State agency for this joint document.

3.3.2 Coordination/Public Involvement. Public involvement procedures of NEPA and SEPA were followed to ensure that issues of concern to the public were properly addressed. The PSEP mailing list of over 2,500 was used to inform interested agencies, organizations, and individuals of study activities through newsletters and public meeting notices. Articles on PSDDA were also included in the PSEP "Puget Sound Notes," a periodic newsletter.

During May 1985, the PSDDA agencies held six public EIS scoping meetings for the Phase I area. These were conducted in Seattle, Everett, Tacoma, Olympia, Bellingham, and Port Townsend. In June 1986, the PSDDA agencies conducted three public EIS scoping meetings that focused on the Phase II area. These meetings were held in Olympia, Port Angeles and Bellingham. Each of the three

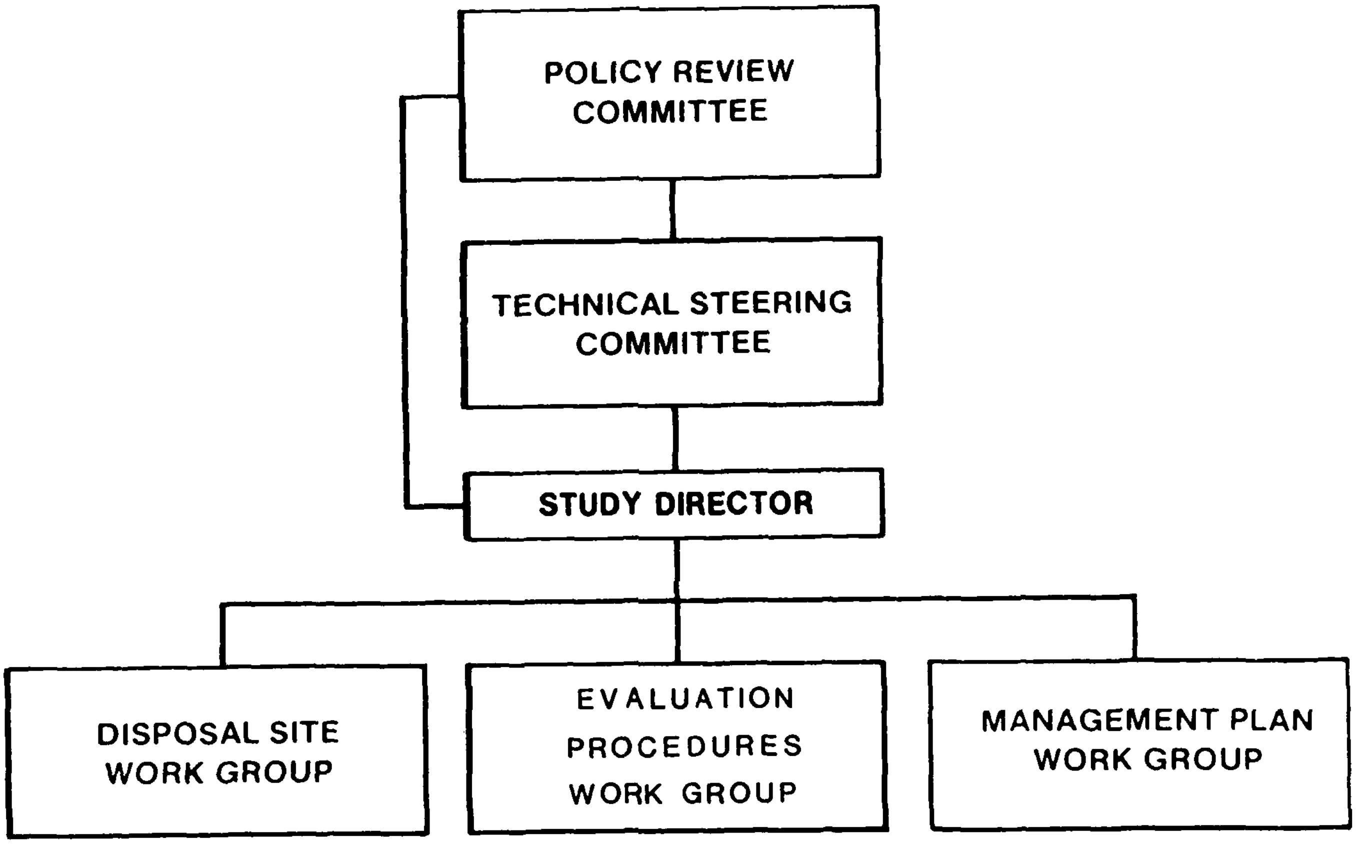


Figure 3.1 Organizational Structure
Puget Sound Dredged Disposal Analysis

work groups conducted a number of working sessions, sharing technical information and giving participants, including citizens, representatives of ports, Indian tribes, environmental groups, local governments, and other Federal and State agencies, opportunities to make recommendations on work group outputs. Routine work group meetings, as well, have been open to public participation.

Several newsletters, containing updates on the status of PSDDA and information on study findings, were published. The first newsletter included comments and issues raised at the May 1985 public meetings and the PSDDA responses. The second issue released in April 1986 contained preliminary study findings for the Phase I area. A third newsletter was distributed in January 1988 to advise the public of the availability of the draft Phase I documents and of the two final Phase I public meetings scheduled and held in February 1988. A fourth newsletter was distributed in early April 1988, providing preliminary findings for the Phase II area and notice of the three public workshops held in late April on these findings.

A major display on dredging was included as part of an ongoing Puget Sound exhibit by the Seattle Aquarium. A "PSDDA" information brochure has been available to the public attending the exhibit, and to those visiting the Federal Center South offices of the U.S. Government. Three public workshops were held in April 1988 on the Phase II preliminary findings were conducted in Steilacoom, Port Angeles and in Bellingham to obtain public comments on these findings. Three public meetings were conducted in April 1989 on the Phase II draft Management Plan Report and DEIS.

PSDDA has been coordinated closely with the PSEP and the PSWQA. Joint funding of common interest technical studies was accomplished with both of these programs. Also, the PSDDA study director and others of the study team were members of advisory committees established by PSEP and PSWQA. Similarly, staff involved in the latter two programs attended PSDDA work group sessions. Other coordination has included, but was not limited to, the following:

<u>Federal</u>
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
U.S. Fish and Wildlife Service
U.S. Navy
U.S. Coast Guard

<u>State of Washington</u>
Department of Natural Resources
Department of Ecology
Department of Transportation
Department of Fisheries
Department of Game
Department of Commerce
Department of Social and Health Services
Parks and Recreation Commission
Puget Sound Water Quality Authority

Indian Tribes
Duwamish Tribal Office
Jamestown Klallam Tribes
Lower Elwha Tribal Council
Lummi Business Council
Muckleshoot Indian Tribe
Nisqually Indian Community
Nooksack Indian Tribal Council
Northwest Indian Fisheries Commission
Point No Point Treaty Council
Port Gamble Business Committee
Puyallup Tribal Council
Sauk-Suaittle Indian Tribe
Skokomish Tribal Council
Small Tribes of Western Washington
Squaxin Island Tribal Council
Stillaguamish Tribal Council
Suquamish Tribal Council
Swinomish Tribal Council
Tulalip Board of Directors
Upper Skagit Tribal Council

Local Government
San Juan County
Mason County
Thurston County
Island County
Jefferson County
Whatcom County
Kitsap County
Snohomish County
King County
Pierce County
Clallam County
Skagit County
City of Bellingham
City of Everett
City of Seattle
City of Anacortes
City of Tacoma
City of Olympia
City of Port Angeles
Association of Washington Cities
Association of Washington Counties
Puget Sound Council of Governments (PSCOG)
Municipality of Metropolitan Seattle (Metro)

Ports
Port of Edmonds
Port of Bellingham

Ports (con.)
Port of Everett
Port of Seattle
Port of Skagit County
Port of Anacortes
Port of Port Townsend
Port of Tacoma
Port of Port Angeles
Port of Bremerton
Port of Olympia
Washington Public Ports Association

Other Public Organizations
Washington Environmental Council
Puget Sound Alliance
Greenpeace
Friends of the Earth

Exhibit C of the Phase II FEIS contains public comments recieved on the draft EIS and the repsonses by the PSDDA agencies. Exhibit D of the Phase II FEIS contains other pertinent correspondence from the Washington Department of Fisheries (WDF), Lummi Tribal Fisheries, Port of Port Angeles, Port of Port Townsend, Port of Olympia, Port of Anacortes, Port of Bellingham and various other interests including commercial and sport fishing groups. The WDF was instrumental in the selection of the Bellingham Bay site. Lummi Tribal Fisheries continues to oppose any disposal site in Bellingham Bay. A special meeting was held with WDF in June 1989 to resolve WDF concerns over the Port Angeles and Port Townsend sites.

3.3.3 Consideration of the State of Washington Puget Sound Water Quality Authority's Plan. The Puget Sound Water Quality Plan, adopted December 17, 1986, was carefully considered by the PSDDA agencies in developing the PSDDA Management Plans for Phase I and Phase II. The contaminated sediment and dredging program of the PSWQA plan contains a sediment program goal "to reduce and ultimately eliminate adverse effects on biological resources and humans from sediment contamination throughout the Sound by reducing or eliminating discharges of toxic contaminants and by capping, treating, or removing contaminated sediments." The PSWQA plan, as modified in October 1988, also adopts the following policies which are to be pursued by all State and local agencies in actions affecting sediment quality, including rulemaking, setting priorities for funding and actions, and developing permit programs:

a. "All government actions will lead toward eliminating the presence of sediments in the Puget Sound basin that cause adverse effects to biological resources or pose a serious health risk to humans.

b. Programs for management of dredging and disposal of sediments should result in a net reduction in the exposure of organisms to adverse effects.[1/]

c. Sediment cleanup programs (which may include capping in place) shall be undertaken when reasonable to reduce, with the intent of eliminating, the exposure of aquatic organisms to sediments having adverse effects."

"1/The intent of this policy is that dredging and disposal contribute to the cleanup of the sound by allowing unconfined, open-water sites to have only low levels of contamination and to dispose of more contaminated sediments in a manner that prevents continued exposure of organisms to adverse effects. For proposals where dredging will expose contaminated sediments, project-specific mitigation measures may be required."

In developing these policies, the PSWQA formalized a long term goal of "no observable harm to the Puget Sound ecosystem from human-caused contamination." The PSWQA plan emphasizes pollution control of all sources as the means of achieving this goal and thereby preventing future contamination of marine sediments. Development of guidelines for dealing with existing contamination is called for by the plan.

Dredging and dredged material disposal is one of over 10 key features of the PSWQA plan. However, the relative importance of dredging and dredged material disposal, in terms of water quality impacts, is considered by the PSDDA agencies and the public to be less than many of the other features such as nonpoint source pollution control, shellfish protection, and municipal and industrial discharges.

The relationship of the PSDDA management plan to the PSWQA goal and policies is discussed in the relevant sections of the FEIS.

3.4 Management Plan. The PSDDA Phase II management plan consists of all elements of dredged material management required for unconfined, open-water disposal. These are: (a) disposal sites, (b) dredged material evaluation procedures, (c) disposal site management, (d) disposal site environmental monitoring, and (e) dredged material data management. The following chapters describe in detail the various elements of the management plan. Chapter 9 presents how the plan will be implemented, including the roles and responsibilities of each of the four PSDDA agencies.

CHAPTER 4. SELECTED DISPOSAL SITES

4.1 Introduction. This chapter describes the public, multiuser sites selected for unconfined, open-water disposal in the Phase II area. The disposal site identification process is presented in the FEIS and is described in detail in the Phase II Disposal Site Selection Technical Appendix (DSSTA)[1/], which also provides information on the historic unconfined, open-water disposal sites managed by DNR. These previously designated sites in the Phase II area were considered but not selected for continued use because they did not meet site selection guidelines. Figure 4.1 shows the location of Puget Sound dredged material disposal sites.

Fish, shellfish, wildlife, and other resources were considered in the disposal site selection process. Impacts on the resources are assessed in the Phase II FEIS.

4.2 Selected Phase II Area Unconfined, Open-Water Disposal Sites. One of the selected disposal sites is located in south Puget Sound and the other four are located in north Puget Sound areas (figure 4.1). The south Puget Sound site is in the Nisqually Reach between Anderson and Ketron Islands. The north Puget Sound sites are in Bellingham Bay, in Rosario Strait, near Port Townsend, and near Port Angeles.

Two of the Phase II disposal sites are located in low bottom current or nondispersive environments. The remaining three sites are in high energy, highly dispersive areas. A typical nondispersive PSDDA disposal site consists of three elements (figure 4.2). The target area (A) and the disposal zone (B) lie within a larger area in which long-term bottom impacts would occur (area C), designated the disposal site. In the nondispersive sites the disposal barges should open within the target area to ensure dredged material is released within the disposal zone. The zone allows for some difficulties in maneuvering. For dispersive sites, the target area, and the zone are the same. Assumptions and dimensions for generalized nondispersive and dispersive sites are described in the following paragraphs.

For a nondispersive site, the disposal site boundary is the limit of the horizontal spread of material over a period of repeated dumps of dredged material after release within the disposal zone, with allowance for flood and ebb tidal currents. Figure 4.3 shows computer study results based on a typical site located on a flat bottom in 400 feet of water with two directional tidal currents of 0.5 knot.

1/Prepared by the Disposal Site Work Group (DWSG).

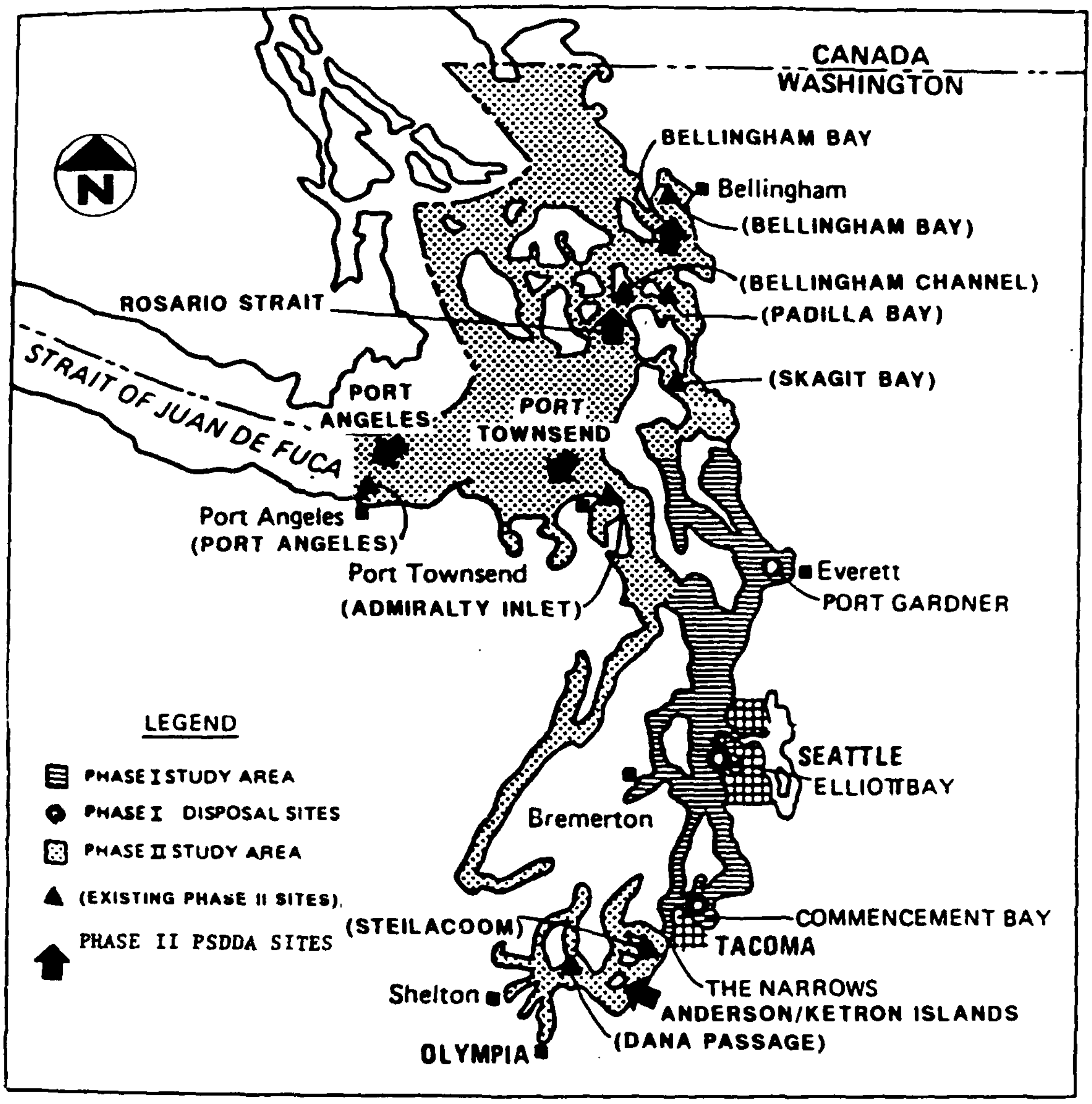


Figure 41. Puget Sound Dredged Disposal Analysis. Location of current and PSDDA Phase II preferred disposal sites.

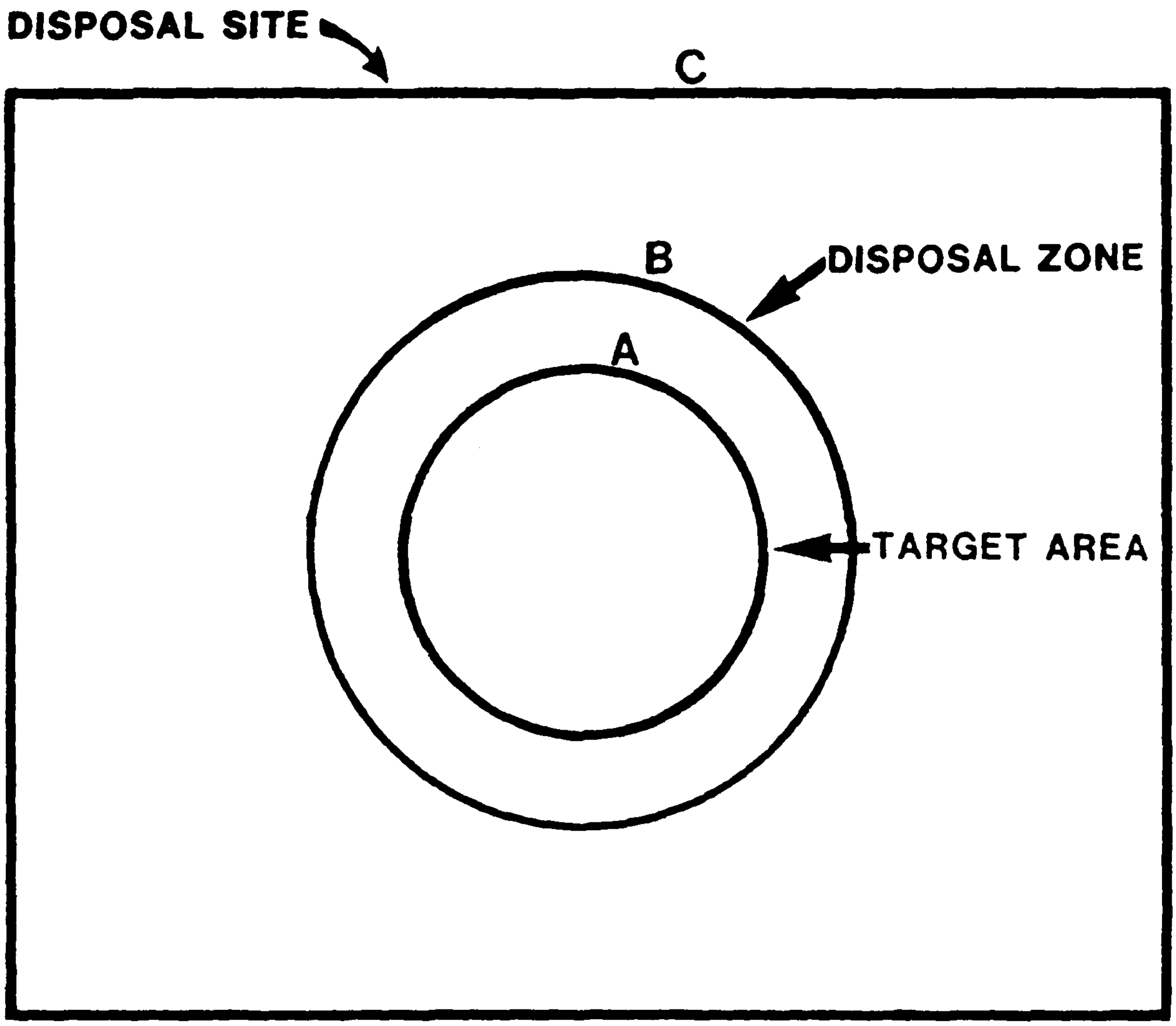


Figure 4.2. Non-dispersive disposal site parameters.

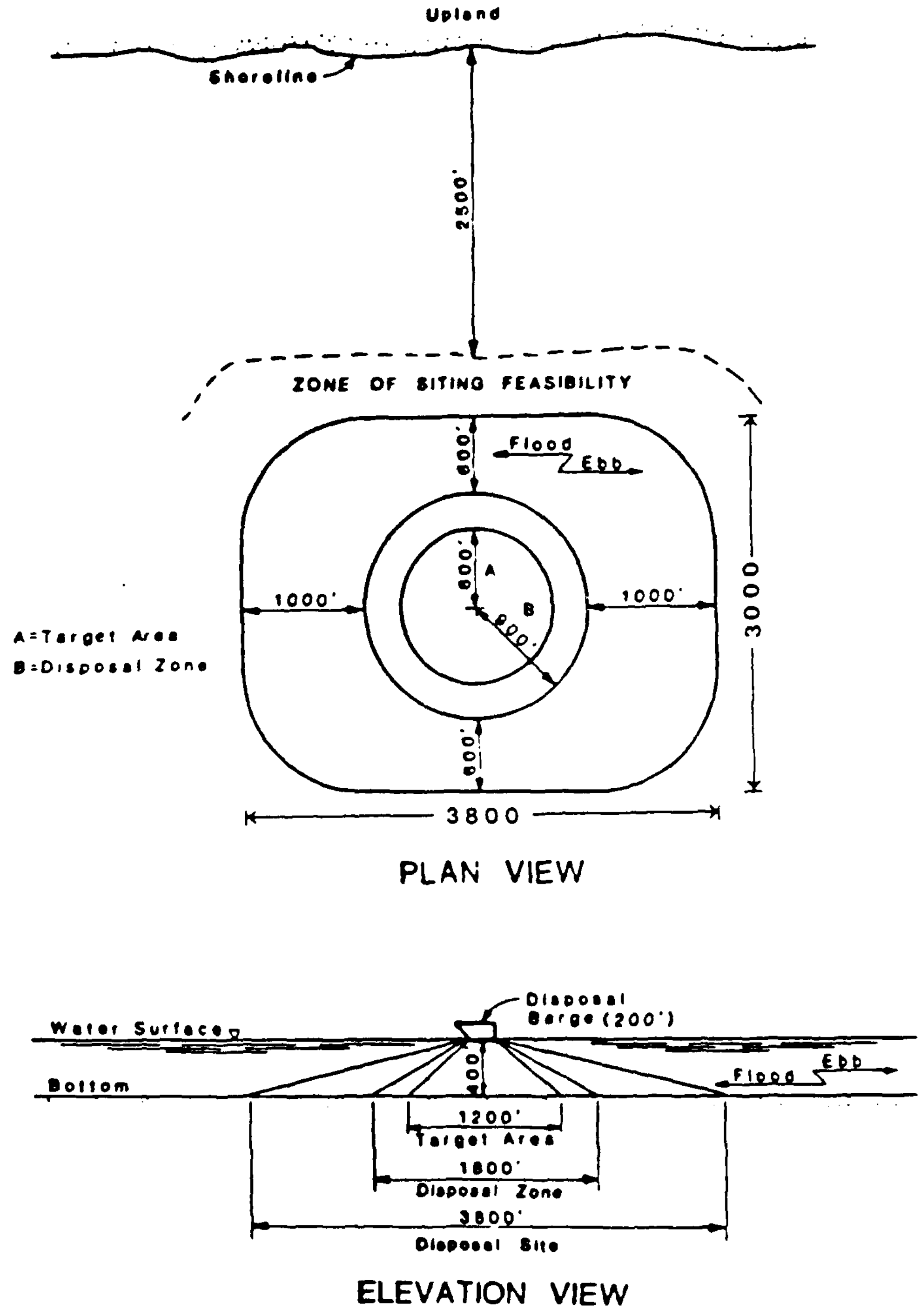


Figure 4.3. Non-dispersive disposal site dimensions.

For a dispersive site the disposal site circumscribes the measurable limits (0.02 inch) horizontal spread for a series of dumps of dredged material released within the disposal zone. Assuming two direction currents, and based on a water depth of 400 feet and an average current of 1 knot, computer studies indicate an ellipse impact area with a long-axis of 7,000 feet as shown in figure 4.4. However, as currents can be from any direction at the dispersive sites, a circle with a diameter of 7,000 feet has been chosen for the Port Angeles and Port Townsend sites. At the shallower Rosario Strait site the site boundary is defined by a circle with a diameter of 6,000 feet. Figure 4.5 shows the site dimensions for the three Phase II dispersive sites, and table 4.1 summarizes location, shape and dimensions.

TABLE 4.1

PHASE II AREA
SELECTED AND ALTERNATIVE DISPOSAL SITES

Site	Latitude Deg	Latitude Min	Longitude Deg	Longitude Min	Depth (Ft) (MLLW)	Disposal Site Dimensions (Diameter) (Ft)	Disposal Site Area (Acres)
Nisqually							
Anderson/ Ketron Island	47	09.43	122	39.40	442	4400 x 3600*	318
Devil's Head	47	09.06	122	45.61	238	4200	318
Bellingham Bay							
Selected	48	42.83	122	33.03	96	3800	260
Alternate 1	48	41.83	122	33.60	98	3800	260
Alternate 2	48	43.82	122	32.50	95	3800	260
Rosario Strait							
Selected	48	30.88	122	43.48	230	6000	650
Alternate	48	30.70	122	42.73	230	6000	650
Port Townsend							
Selected	48	13.62	122	58.95	361	7000	884
Alternate	48	15.28	122	55.60	361	7000	884
Port Angeles							
Selected	48	11.68	123	24.86	435	7000	884
Alternate	48	13.20	123	25.65	445	7000	884

*This site is oval, the rest are circular.

4.2.1 Description of Nondispersive Disposal Areas. The PSDDA Disposal Site Work Group identified several criteria to differentiate nondispersive from dispersive disposal areas. The presence of sandy mud (10 percent sand and 90 percent mud) or finer grained material (mud) was considered indicative of

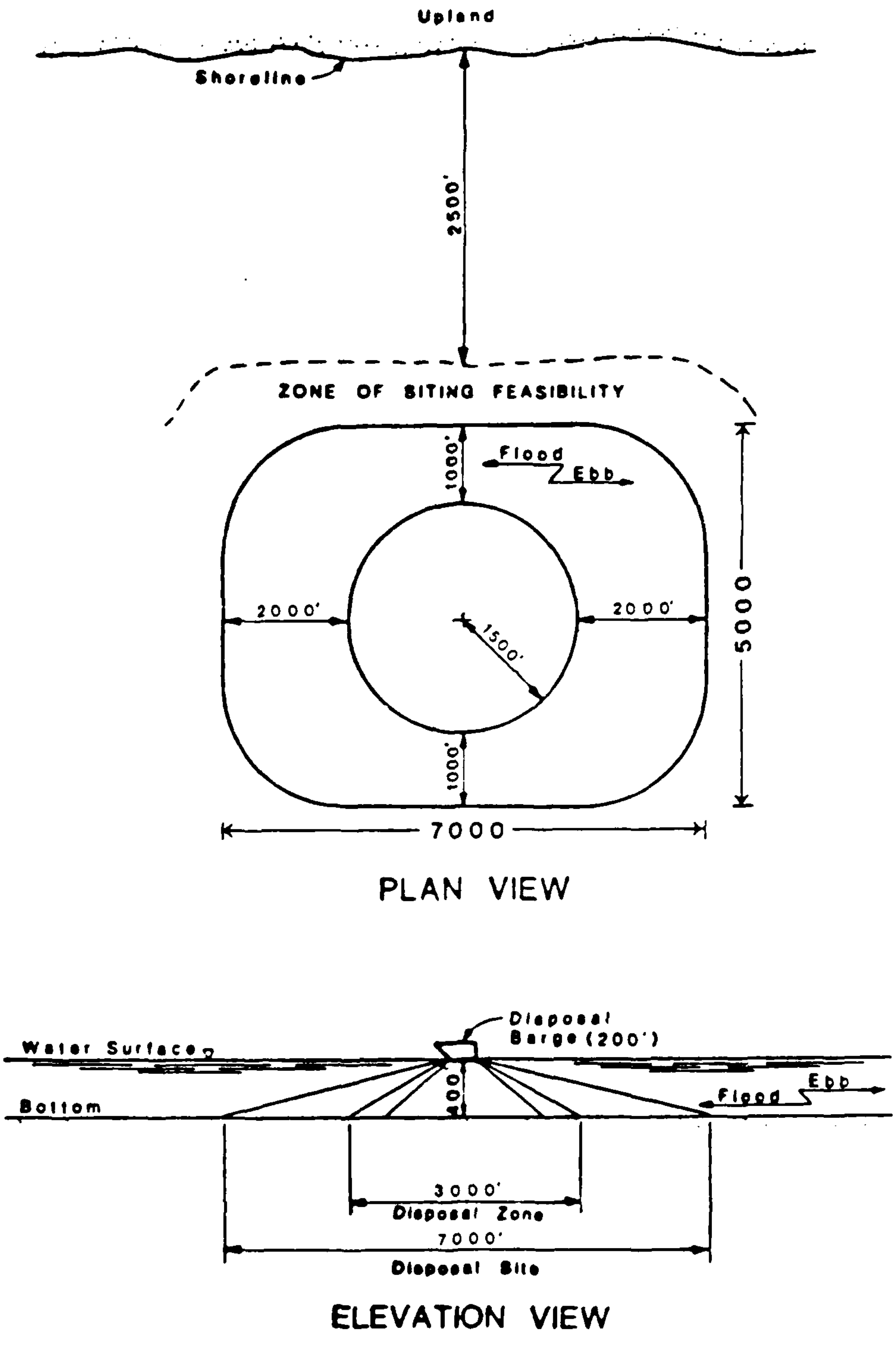


Figure 4.4. Dispersive disposal site dimensions

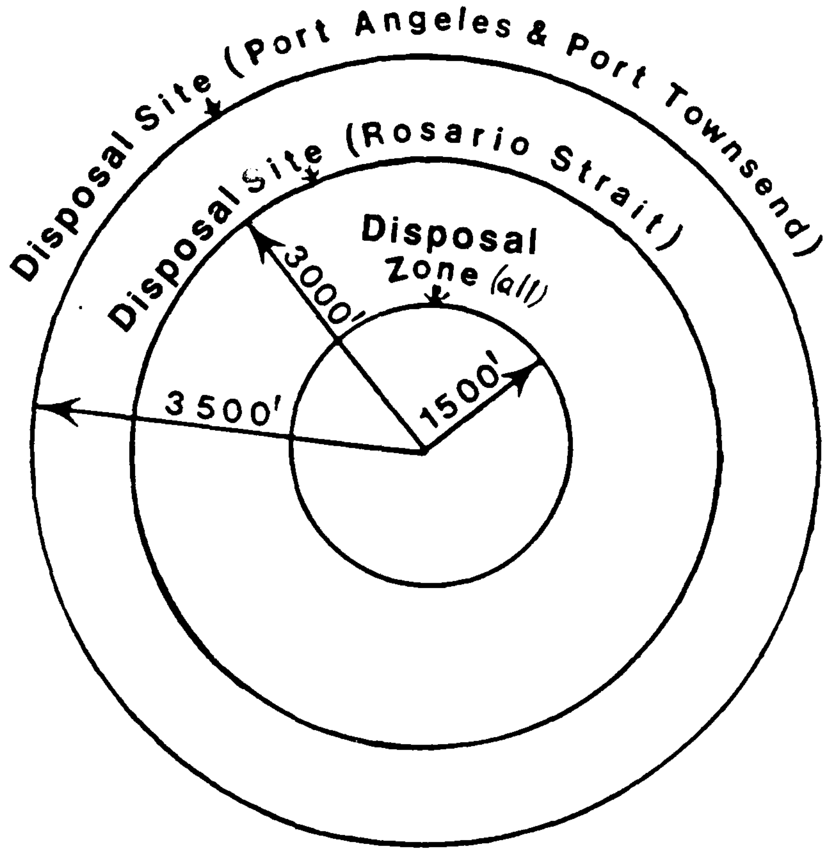


Figure 4.5. Calculated disposal site dimensions for Phase II dispersive sites.

potential low energy areas. Current records were also considered. Zones of siting feasibility (ZSFs) were established that met guidelines designed to protect natural resources and human use conflicts. (Additional information on guidelines used in selecting these nondispersive areas is given in Phase II DSSTA.) Based on these data, alternative nondispersive sites were identified in the Nisqually region of south Puget Sound and in Bellingham Bay.

a. South Sound: Anderson/Ketron Island ZSF 2. The Anderson/Ketron Island ZSF is located midway between these two islands (figure 4.6). The boundary configuration was drawn so that the ZSF follows the bathymetric features of the bottom, which ensure disposed dredged material will be restricted to the site. This was selected as the preferred ZSF for south Puget Sound. The selected disposal site is located at the north end of the ZSF, with a depth of 442 feet MLLW at the center of the disposal zone.

b. South Sound: Anderson Island/Devils Head ZSF 3. The ZSF boundary is located at the south end of Drayton Passage, between Devils Head and Treble Point, and extends into Nisqually Reach (figure 4.7). This was the alternate ZSF for south Puget Sound. Conflicts with herring and groundfish resources were the reasons a site was not selected at this location.

c. North Sound: Bellingham Bay. The south ZSF (containing alternative site A-1) is located between Portage Island and the mainland (figure 4.8). This ZSF was located to avoid navigation lanes, utilities, and marine fish and shellfish resources. Originally the location of the preferred site, it was found to conflict with established bottomfish trawl areas. The depths of all the Bellingham Bay ZSF's are approximately 100 feet MLLW.

The northeastern ZSF (containing alternative site A-2) is located near south Bellingham. The Bellingham Groundfish Trawlers Association suggested this ZSF as an alternative to the south ZSF as it had less potential for conflicts with trawling activity. It was, however, ultimately rejected because of higher crab and shrimp resources than in the south ZSF.

The selected site, located midway between the two alternative sites and is approximately 0.9 nautical mile west of Post Point, was recommended by the Washington Department of Fisheries (WDF) (see exhibit D of the Phase II DEIS for WDF letter of 19 July 1988). The site move was intended to minimize potential conflicts with bottomfish trawlers who operate in the vicinity of the southern site (A-1). Natural resources in the selected site are comparable to those in alternative site A-1. The selected disposal site is closer to denser populations of Dungeness crab than the southern site. However, to minimize potential impacts on crab, WDF also proposed a site use restriction which would prohibit disposal operations from November 1 through February 28 each year. This 4-month restriction is in addition to the normal 3-month dredging closure period that extends from March 15 to June 15 each year when salmon and steelhead smolts are outmigrating. Accordingly, to minimize potential impacts to Dungeness crab and shrimp resources during critical spawning and migration periods the PSDDA agencies have established a 7½-month disposal site closure period (November 1 through June 15).

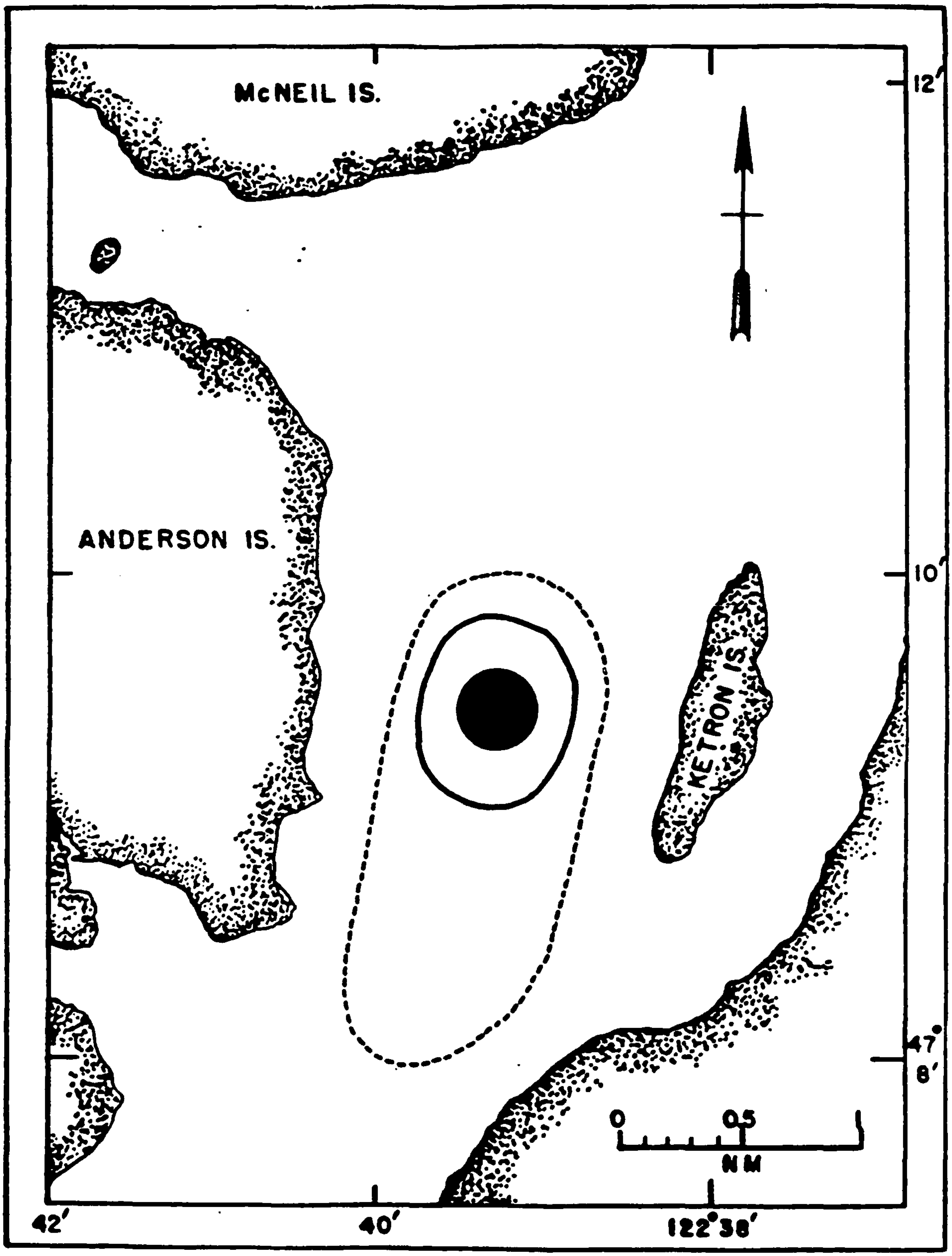


Figure 4.6. The Anderson/Ketron Island ZSF (dashed line), site perimeter (solid line) and disposal zone (solid circle).

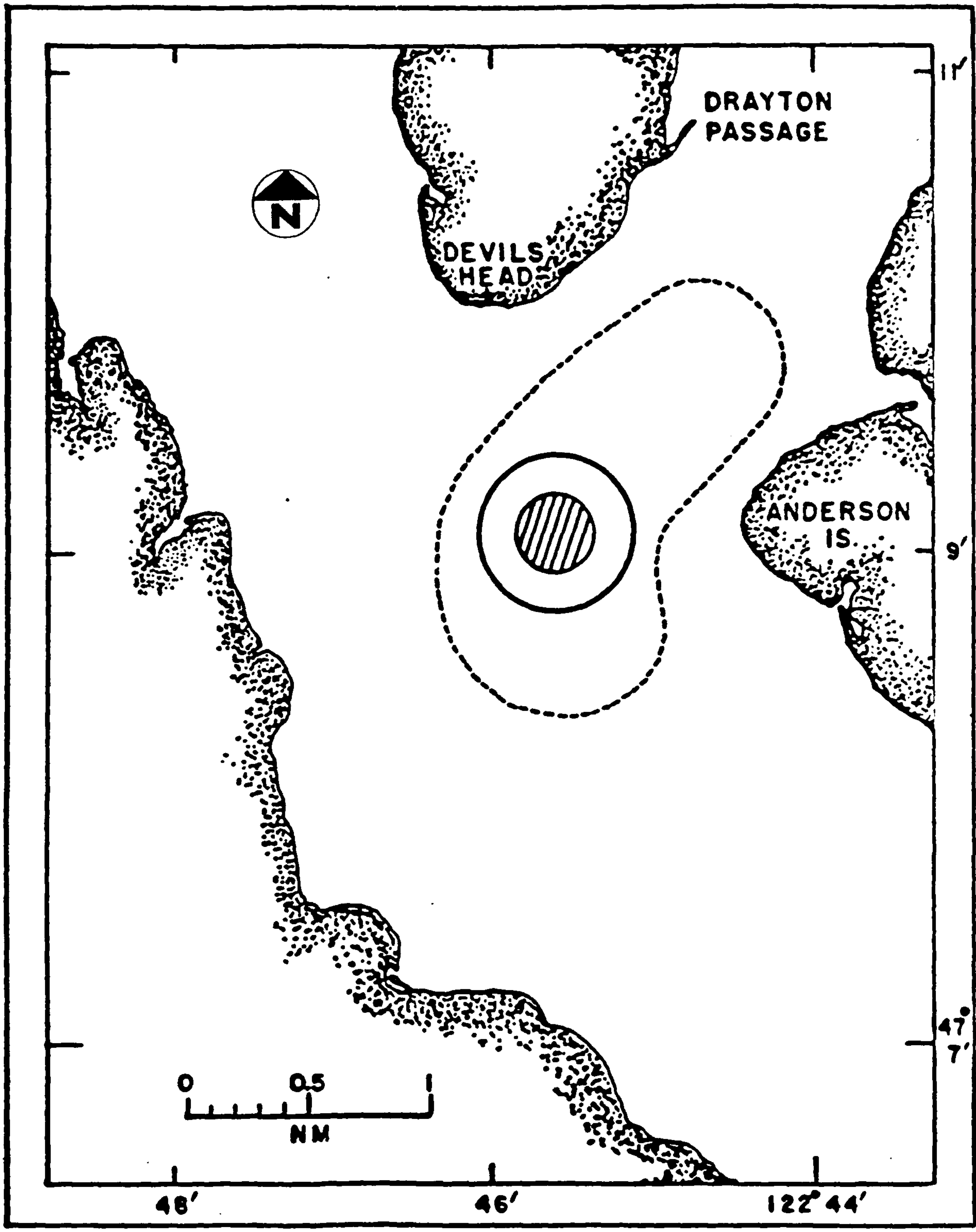


Figure 4.7 The Anderson Island/Devil's Head ZSF (dashed line), disposal site boundary (solid line), and disposal zone (circle).

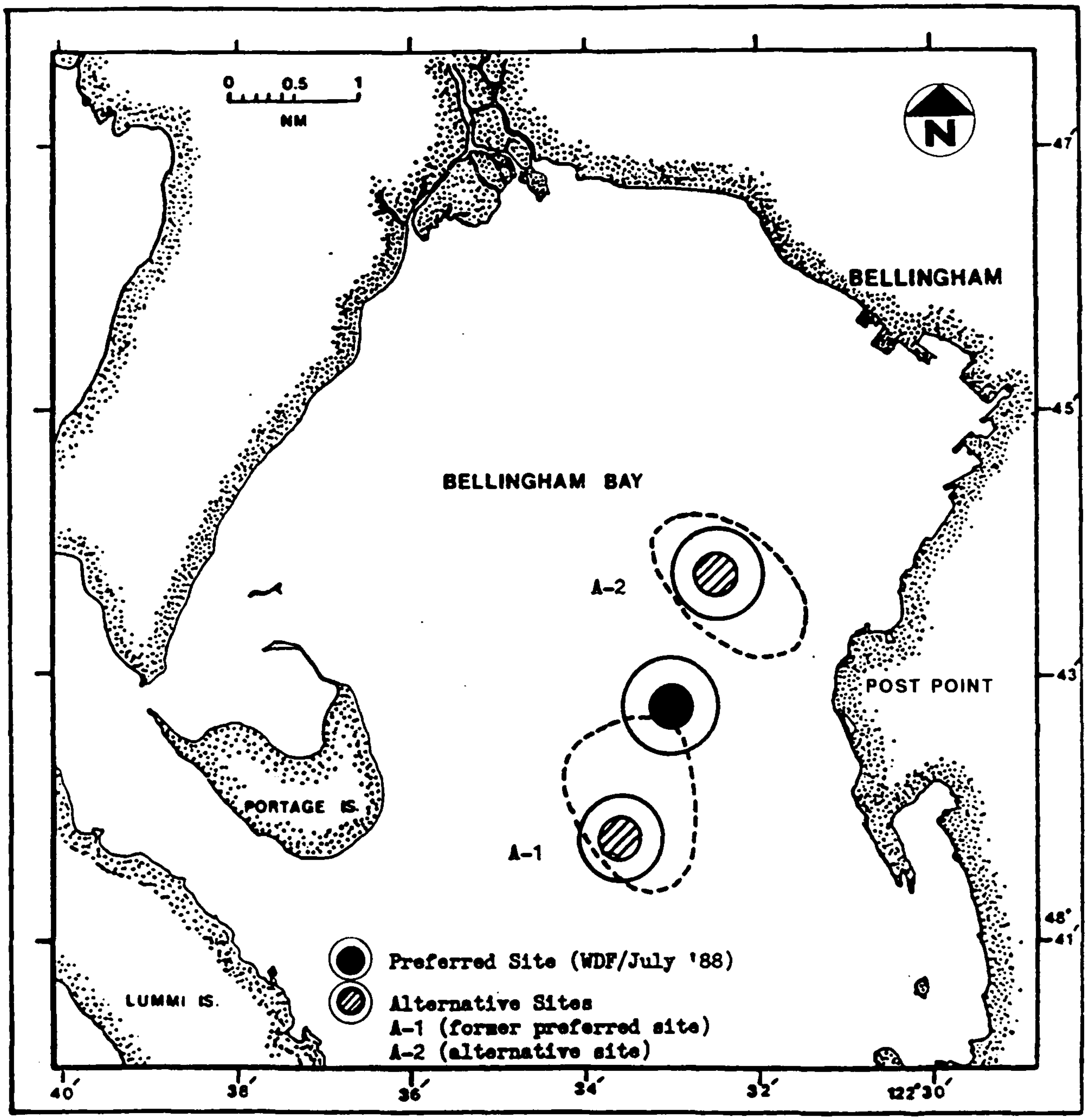


Figure 4.8. The Bellingham Bay ZSF's (dashed lines), disposal site boundary (solid line) and disposal zone (hatched circles for alternative sites and solid circle for preferred site).

4.2.2 Description of Dispersive Disposal Sites. Dispersive ZSF's in the north Puget Sound and Strait of Juan de Fuca were selected based on considerations for marine shellfish and fisheries resources and human use concerns. For these areas, it was not possible to locate nondispersive ZSF's due to significant resource conflicts in nearshore waters. Further offshore, nondispersive conditions were violated. Dispersive ZSF's were rated with regard to erosive current speeds which would rapidly move and disperse dredged material away from the disposal zone (see Phase II DSSTA). Highly dispersive disposal sites were identified in Rosario Strait, near Port Townsend and near Port Angeles.

a. Rosario Strait. The northern border of the Rosario Strait ZSF is located about 1 nautical mile south of Cypress Island (figure 4.9). This location was adjusted slightly to the north and east of the original site to avoid a cable crossing area. The selected site is located in the center of the ZSF, while the alternative site is located approximately 0.5 nautical mile to the east. Both sites are located in about 230 feet (MLLW) of water.

b. Port Townsend. The southern boundary of the ZSF is located approximately 4.6 nautical miles from Port Townsend. The bottom topography at this site is highly variable. The depth at the center of the ZSF is approximately 420 feet (MLLW) (figure 4.10). The preferred disposal site is located along the southwest border of the ZSF in about 361 feet of water. The alternative disposal site is located along the eastern ZSF border at the same depth.

c. Port Angeles. The southern boundary of the ZSF is located about 4 nautical miles north of Port Angeles (figure 4.11). The eastern one-half of the originally circular site was eliminated to provide a buffer between the ZSF and a popular bottomfish trawl fishery in a rocky outcropping area, called the Rockpile, located to the northeast. The preferred disposal site is at the southern tip of the ZSF in about 435 feet of water. The alternative disposal site is closer to the ZSF center at a depth of 445 feet (MLLW).

4.3 Disposal Guidelines. The Phase I disposal guidelines will be used for the Phase II nondispersive sites. For the Phase II dispersive sites a more restrictive guideline will be followed as environmental effects monitoring is not practical at these locations due to high currents. The dredged material evaluation procedures used to assess the technical suitability of the material for unconfined, open-water disposal are designed to ensure that unacceptable adverse effects will not result from dredged material disposal. Chapter 5 (table 5.1) and exhibit A describe the disposal guidelines.

Project evaluations, as required under specific Federal and State authorities, will establish actual dredged material volumes that can be placed in unconfined, open-water disposal sites. However, based on the selected disposal guidelines, and best-available sediment chemistry data, an estimated 4.7 million c.y. of future dredged material could be found acceptable for unconfined, open-water disposal through the year 2000 (about 83 percent of the 5.7 million c.y. that might be considered for disposal at the Phase II area

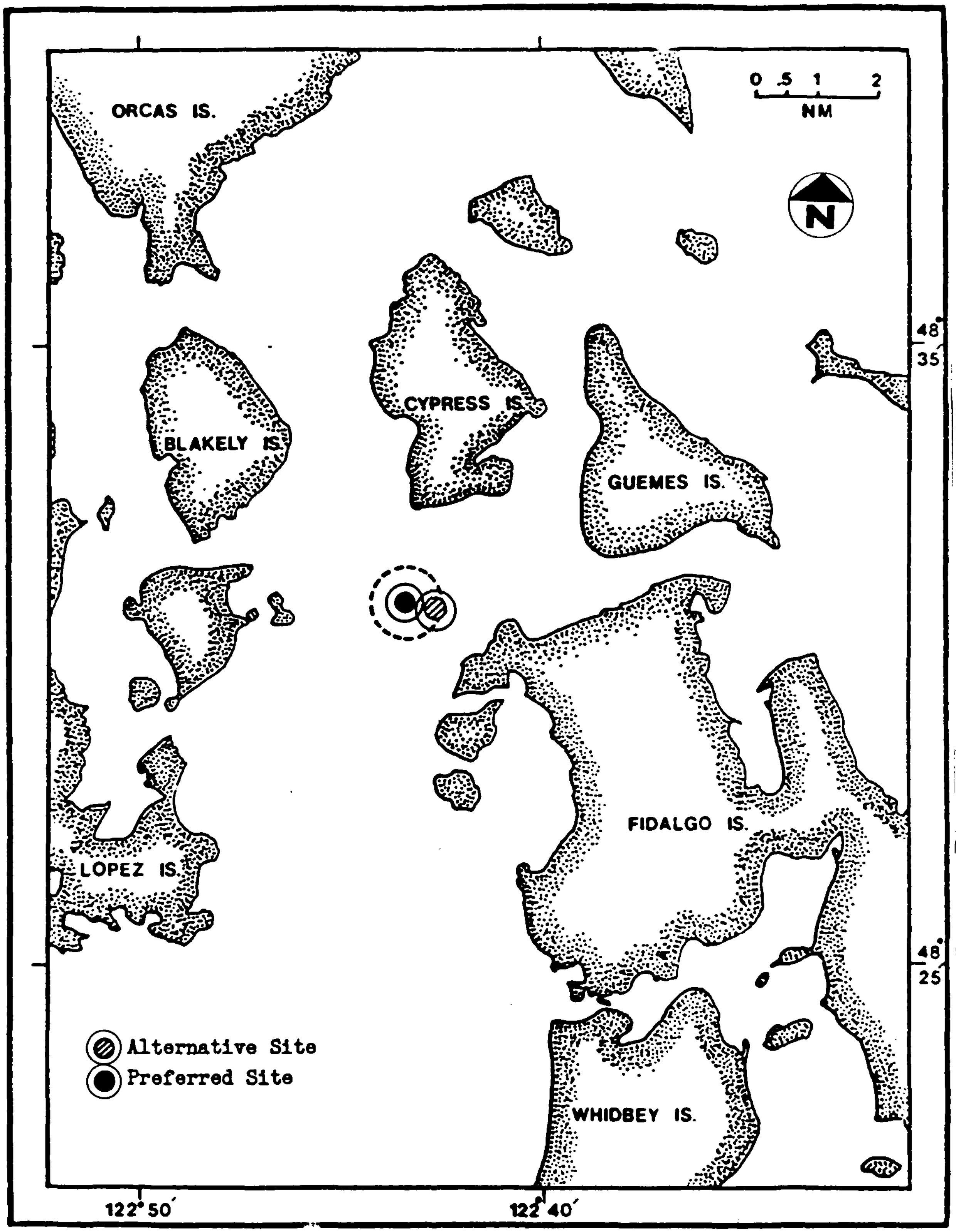


Figure 4.9. Rosario Strait ZSF (dashed line), disposal site boundary (solid line) and disposal zone (solid circle for preferred site and hatched circle for alternate site).

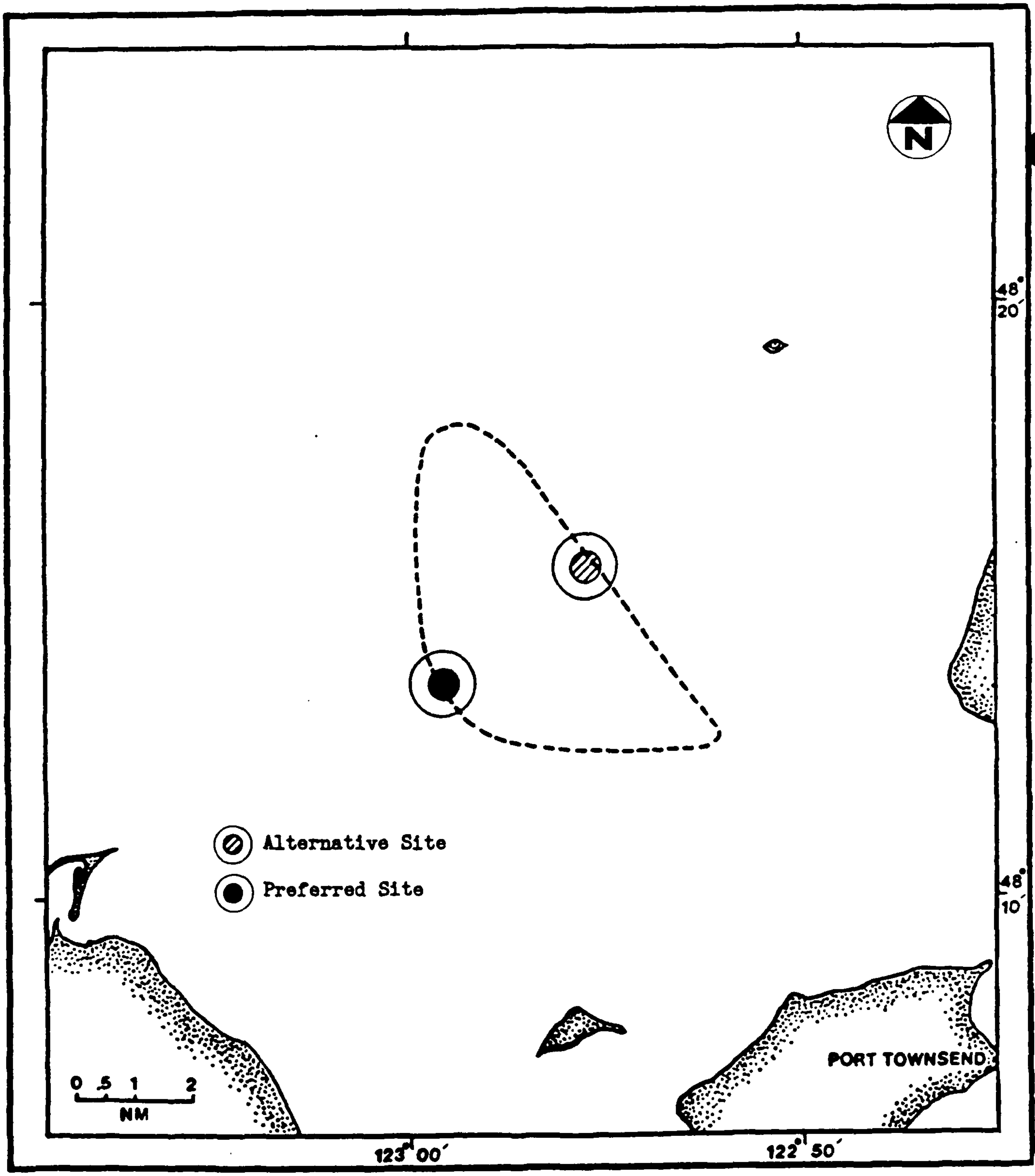


Figure 4.10. Port Townsend ZSF (dashed line), disposal site boundary (solid line), and disposal zone (solid circle for preferred and hatched circle for alternate site).

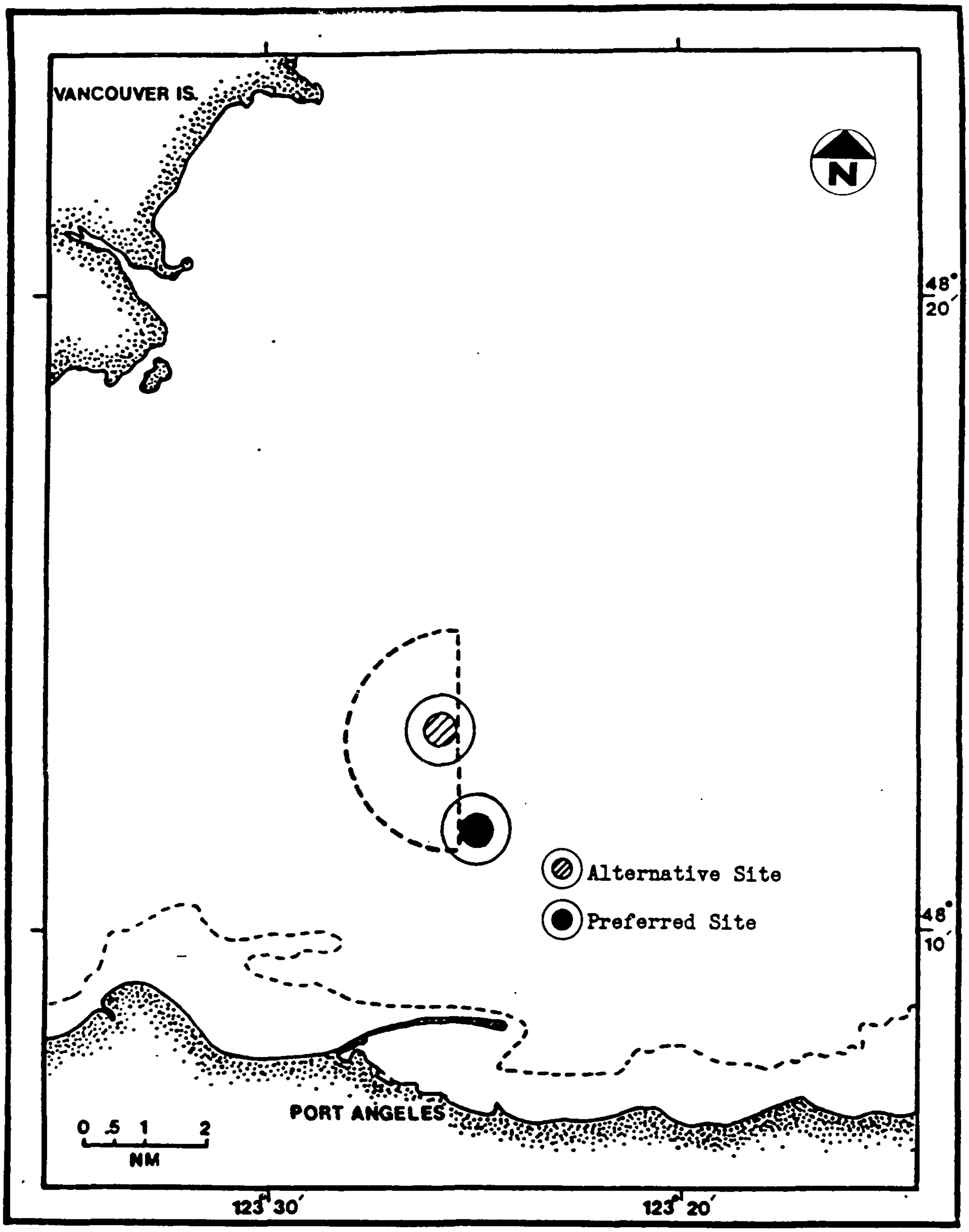


Figure 4.11. Port Angeles ZSF (dashed line), disposal site boundary (solid line) and disposal zone (solid circle for preferred, hatched for alternate).

PSDDA sites).[1/] This compares with 3.2 million c.y. of dredged material actually placed in Phase II waters over the past 15 years. In the past not all acceptable material was placed at public disposal sites. Some was used for landfill or other beneficial purposes. This is also expected to be true in the future.

[1/] Lummi Bay Marina initial dredging (1,470,000 c.y.) would be expected to be suitable for disposal at a PSDDA site. If this volume were included, then about 85 percent of the total Phase II future dredging volume (7,187,000 c.y.) would be suitable for unconfined open-water disposal.

CHAPTER 5. PSDDA DREDGED MATERIAL EVALUATION PROCEDURES

5.1 Introduction. The evaluation procedures for determining the suitability of sediment for unconfined, open-water disposal represent a combination of best available tests and guidelines based on current knowledge. They were recommended by the Evaluation Procedures Work Group (EPWG) and adopted by the PSDDA agencies. This combination of tests is consistent with applicable regulatory requirements which specify that no single test can appropriately address all assessment needs. Annual evaluations are being made of permit decisions, state-of-the-art scientific testing methods and regulatory guidelines, and results of the site environmental monitoring program in order to ensure that the most environmentally appropriate and cost effective evaluation procedures are being employed for dredged material management in Puget Sound. This chapter summarizes updates in Phase II of the PSDDA study to the Phase I dredged material evaluation procedures (Phase I Evaluation Procedures Technical Appendix (EPTA, 1988)). The procedures discussed include physical, chemical, and biological tests, and sampling and disposal guidelines used by regulatory agencies in making decisions on suitability of dredged material for unconfined, open-water disposal.

The PSDDA Phase I and II evaluation procedures, including disposal guideline values that will be applicable with the completion of the filing of the Phase II Federal Record of Decision, are presented in exhibit A of this Phase II Management Plan Report (MPR). All of the policies and procedures presented in the Phase I MPR and supporting documents are applicable to the Phase II area, except as explicitly modified herein. This chapter reviews changes to the PSDDA evaluation procedures. Testing procedures are similar for the dispersive and the nondispersive sites; however, for the dispersive sites a different interpretive guideline is used (see section 5.8. below). Adopted changes are expected to be issued as revised pages to EPTA (1988).

Table 5.1 summarizes these elements by topic.

TABLE 5.1

MODIFICATIONS/CLARIFICATIONS TO PSDDA EVALUATION PROCEDURES

Paragraph	Topic
5.2	**Adjustments to PSDDA screening and maximum levels (SL and ML) and human health (bioaccumulation) lists:** Nickel, pentachlorophenol, di-n-octyl phthalate, butyltins, compounds associated with Clean Water Act 304(1)-listed pulp and paper plants, and polychlorinated biphenyls.
5.3	**Clarification of bioassay testing procedures, and performance, and interpretive guidelines for:** larval solid phase (bivalve or echinoderm) test, the 10-day juvenile infaunal species solid phase acute bioassay (*Neanthes arenaceodentata*) test, Microtox, and statistical interpretation of biological tests.

TABLE 5.1 (con.)

Paragraph	Topic
5.4	**Clarification of recommended procedures and limits of detection for organic compounds.**
5.5	**Clarification of metals extraction procedures and associated limits of detection.**
5.6	**Clarification of amphipod bioassay reference stations and performance standards.**
5.7	**Sampling plan clarifications:** recency guidelines, archiving sediments for post-dredging surface evaluations, and debris inspection.
5.8	**Dispersive site disposal guideline.**
5.9	**Area rankings for Phase II area.**
5.10	**Status of the chronic sublethal test.**
5.11	**Clarification of sediment holding times for chemical analyses and bioassays.**

Paragraphs 5.2 through 5.7 and paragraph 5.11 modify or clarify existing Phase I evaluation procedures and are applicable to the Phase II area. Paragraphs 5.8 and 5.9 are uniquely applicable to the PSDDA Phase II area. Paragraph 5.10 discusses status of an issue that merits the continuing attention of the PSDDA agencies.

5.2 Adjustments to PSDDA screening and maximum levels (SL and ML) and human health (bioaccumulation) lists: nickel, pentachlorophenol, arsenic, antimony, di-n-octyl phthalate, butyltins, compounds associated with Clean Water Act 304(l)-listed pulp and paper plants, and polychlorinated biphenyls.

The PSDDA agencies have adjusted some of the Phase I screening and maximum level values and human health (bioaccumulation) triggers in light of information received during Phase II studies based on the expanded Puget Sound Database, experience gained through initial PSDDA testing, and an independent review of the protectiveness of the PSDDA guidelines.

a. Background. As described in the Phase I MPR (section 5.4.2), the PSDDA agencies adopted a tiered dredged material testing approach incorporating an assessment of chemical information resulting in a determination

whether biological testing of the material is required. Assessment of suitability of the material for unconfined open-water disposal is based on results of the chemical testing and any required biological testing. Among other sources of information, the PSDDA agencies considered sediment quality values derived from the 1986 Puget Sound Database to guide decisions on the need for chemical and biological testing.

During development of PSDDA, different approaches were considered and assessed to determine the reliability of selected sediment quality values in correctly predicting toxicity in the Puget Sound sediments Database.

During Phase I, the PSDDA agencies compiled a list of sediment chemistry values (see EPTA [1988] chapter II-7, in particular sections II-7.3 and II-7.4, for description of this development) that were the most reliable values available at that time. A single set of chemical values (one for each chemical of concern) was found not to be simultaneously sensitive (to identify all toxic sediments) and efficient (to ensure that only toxic sediments were identified). For this reason, environmental protection was embodied in a set of lower values (screening levels or SL's), while cost efficiency and environmental protection were ensured by a set of higher values (maximum levels or ML's) (EPTA (1988), p. II-94). Reliance on multiple values assure that these objectives of dredged material management are met.

An SL is defined as a concentration of a chemical of concern below which there is no reason to believe that dredged material disposal would result in unacceptable adverse effects. SL's are used as guidelines for determining when biological testing should be required. Thus, for dredged material with chemical concentrations below the screening level values, biological testing is not required to determine material suitability for unconfined, open-water disposal.

An ML is defined for each chemical of concern as a threshold concentration for each chemical of concern, above which there is reason to believe that the material would be unacceptable for unconfined, open-water disposal. The ML sets the upper limit of chemical concentration for which the standard PSDDA biological tests provide a sufficient basis for regulatory decisionmaking. Use of the SL and ML values in testing of dredged material is described in the attached draft exhibit A, figures A-1 to A-3, and EPTA (1988), section 2.4.

The PSDDA agencies derived ML's for most of the chemicals of concern by using the 1986 Database value for the highest Apparent Effects Threshold (AET). The AET approach is described in EPTA (1988) II-7.2.2. The four biological indicators used are amphipod, larval sediment test, benthic infaunal index, and Microtox. Because a range of biological indicaters are used, there are lowest (most sensitive species or measure) and highest AET (least sensitive species or measure). The rationale for using the highest AET is discussed in EPTA (1988, loc. cit.). SL's were derived as follows:

Set the SL to 10 percent of the ML, provided that the value equals or exceeds the average concentration for the chemical in Puget Sound reference areas, and the value is less than the lowest AET determined for a range of biological indicators.

For a subset of the chemicals of concern, there are human health concerns related to biological accumulation or magnification of the concentratation of the chemicals which could be consumed in sea food. The derivation of these values and calculation of a trigger value for sediment bulk chemistry which sets a requirement for running bioaccumulation tests are discussed in EPTA (1988) on pp. II-6.4.1 and II-8.3.4.

b. New Information Gained During Phase II. Reliability of the sediment quality values was assessed by applying the values to the expanded Database for Puget Sound sediments and determining their performance in predicting impacts on chemistry alone which are confirmed by biological measures. The assessment of reliability is contained in the following report:

Report i. Barrick, R., L. Brown, and S. Becker, 1988. Sediment Quality Values Refinement: Volume II--Evaluation of PSDDA Sediment Quality Values. Report prepared by PTI Environmental Services, Inc., for EPA.

The SL values have been shown to be environmentally protective, and the ML values to be efficient predictors of biological responses in sediments. This reliability check confirms the appropriateness of these chemical disposal guidelines in Puget Sound regulatory applications.

PSDDA SL values predicted from 92 to 100 percent of the stations exhibiting adverse biological effects in the added surveys. Physical characteristics of sediments/habitat (such as high proportions of fine grain sizes or physical disturbance of benthic communities by waves) and chemical analysis problems in the surveys (resulting in higher-than-acceptable limits of detection or chemicals which were not analyzed) were considered to be the most significant contributors in the stations which were not correctly predicted by the PSDDA SL. The report concluded that PSDDA SL values do not need to be modified to enhance their environmental protectiveness.

PSDDA ML values are used as guidelines for identifying contaminated sediments that are likely to be unsuitable for disposal at unconfined, open-water, sites based on chemical data alone. Depending on the results of each single biological test or ecological indicator considered, 77 to 100 percent of the additional stations predicted by current PSDDA ML values to have adverse biological effects in the additional surveys actually exhibited such effects. At stations where amphipod and benthic infaunal data did not demonstrate all of the adverse effects that were predicted by ML values, 72 percent showed adverse impacts in at least one biological indicator. When all biological indicators are considered, an additional 72 percent of the "single-indicator unpredicted" stations are correctly predicted. The newly-derived highest AET values from the expanded 1988 Puget Sound Database are 100 percent predictive for oyster larvae and Microtox, 85 percent predictive for amphipod bioassays, and 91 percent predictive for the benthic infaunal depression indicator. The report concluded that an enhancement in predictiveness of ML values is possible with revisions to update the ML list from the 1988 highest AET.

Information from a second report has also been considered by the PSDDA agencies in determining whether to update SL, ML, and bioaccumulation trigger values. The report is:

Report ii. U.S. Department of the Navy. 1989 (June). Environmental Assessment: Element 1. Carrier Battle Group Homeporting in the Puget Sound Area, Washington State. Appendix E. An Assessment of Potential Chronic Sublethal Effects Related to Element 1 of the U.S. Navy Everett Homeport Project. Prepared by Parametrix, Inc., and E.V.S. Consultants, Inc. Principal author for Appendix E: Dr. P. M. Chapman.

As a portion of this report, the PSDDA SL's (and to a lesser extent, ML's) were examined for protectiveness using a risk-based assessment based on a wide-ranging literature review of chemical-specific effects.

Both acute toxic and chronic sublethal effects of the PSDDA SL's and ML's were considered, but the emphasis was on the latter effects which generally occur at lower levels than acute toxic effects. Equilibrium partitioning was used to estimate the minimum sediment bulk chemical levels that would produce a response in the aqueous phase, and the sediment bulk chemical levels were then compared to the PSDDA SL's and ML's.

The report warns that results predicted from equilibrium partitioning may differ from realized responses due to unconsidered factors such as pH, reducing state, salinity, and the synergistic effects of combined chemicals. Also, sediment-phase bioavailability of a toxicant (particularly metals) may differ from, and is usually less than, its bioavailability when dissolved in the aqueous phase. The current literature consists of many more reports on aqueous phase (dissolved) chemical responses than sediment (solid phase) responses by organisms.

Report ii concludes that, for 42 of 58 PSDDA chemicals of concern for which an equilibrium partitioning coefficient could be found or calculated, the PSDDA SL's are protective of acute toxic and chronic sublethal effects to marine species at the disposal sites, with one exception. Excluding that exception, the equilibrium-partitioning-derived sediment concentration always exceeded the PSDDA ML by a factor from 2 (in alpha-chlordane) to 10^9 (in bis[2-ethylhexyl]phthalate). (The exception is 1,2,4-trichloroethene and it is considered below in subparagraph c(7).) Since most SL's are 1/10 ML, SL's were exceeded by an order of magnitude greater than that stated.

c. Adjustments to SL's, ML's Bioaccumulation Trigger Values, and Listing of Chemicals of Concern for Limited Areas and Other Chemicals. The PSDDA agencies have considered adjusting all of the ML's which have changed as a result of new data in the 1988 Puget Sound Database or because of quality-assurance adjustments (elimination of other datasets) to the Database. At this time, the agencies decided to modify only those ML's for which experience supports a need for change. Other ML values for which AET have changed as a result of new data and new analytic techniques will be addressed during the 1990 PSDDA Annual Review Meeting.

The first six chemicals of concern listed below will be modified. The seventh is considered, but not proposed for change; and the eighth and ninth subparagraphs deal with chemicals that will be treated as other than general chemicals of concern.

(1) Nickel was not used in the calculation of reliabilities of SL's and ML's in report i, because nickel occurs above the SL even in reference areas for which no biological effects have been observed. This occurrence suggests that it is primarily (although possibly not always) a naturally-occurring mineral which is not well correlated with observed biological effects. This is not to say that nickel is not potentially a toxic substance in Puget Sound, however.

In the PSDDA list of chemicals of concern (June 1988 EPTA, pages 11-207 and 11-209) another compound, pentac ɔrophenol (PCP), was also based on a preliminary AET. (A preliminary AET is assigned to a chemical for which no stations exist in the Database that show biological effects with a chemical concentration higher than the AET.) PCP was not assigned an ML, and the SL was set equal to the preliminary AET.

The PSDDA agencies will treat nickel in the same fashion: remove the current ML of 120 parts per million (ppm) dry weight basis[1]/, and set the SL equal to the highest AET from the 1988 data base (a total acid digest value of 140 ppm). The result of this change would be that, though nickel could activate PSDDA biological testing requirements (and any toxic effects would be discovered in the biological testing), it would only do so when it was present at levels higher than background levels in Puget Sound. Also, lacking an ML, nickel would not be considered in the tier 2 decision path leading to the dredger option for special biological testing of sediments (see figure A.1, MPR exhibit A). The sediment bioaccumulation trigger value for nickel would be changed from 43 to 1,022 ppm in accordance with the equation given in EPTA (1988) on page II-73 for a compound with only an SL.

(2) The second modification is pentachlorophenol, mentioned above, for which a defined highest AET is available in the expanded Puget Sound Database. The SL would drop from 140 parts per billion (ppb) (dry weight basis) to 69 ppb, and the ML would be 690 ppb. For comparison, the mean reference area concentration is 33 ppb. This change would result in a requirement for biological testing of dredged material when levels of PCP exceed the new SL, and consideration of this chemical in tier 2 decisions leading to the dredger option for special biological testing. It would also result in a lower (504 versus 1,022 ppb) sediment chemistry trigger value for bioaccumulation. For more information on PCP, see paragraph (7), below.

[1]/ Throughout chapter 5, the convention is adopted that sediment solids (dry weight basis) and tissue solids (wet weight basis) are reported as parts per million (ppm), equivalent to mg/Kg, and parts per billion (ppb), equivalent to ug/Kg. For water, these are given on a volume basis (e.g., mg/L are ppb).

(3) The third SL modification is di-n-octyl phthalate, in which case the highest AET has gone down from 69,000 ppb to 6,200. Phthalates are not used to "fail" dredged material (see EPTA (1988), page 11-209, note c), therefore this change should not affect volumes of dredged material that would be found suitable for disposal at PSDDA sites. There is no bioaccumulation trigger value for di-n-octyl phthalate.

(4) The fourth modification is antimony, for which the lowest AET in the 1988 Puget Sound Database is 150 ppm (dry weight basis), and the highest AET is 200 ppm. This compares with the former highest AET of 26 ppm, which resulted in the current PSDDA ML of 26 ppm, and an SL of 2.6 ppm. The PSDDA SL for antimony is below the mean reference area value of 0.38 ppm. Report i recommends that PSDDA update the antimony SL and ML to the 1988 values. The PSDDA agencies have decided to change the SL and ML to 20 and 200 ppm, respectively, at this time to avoid possible conflicts with other Puget Sound programs. The change would also adjust the bioaccumulation trigger value for antimony from 19 to 126 ppm. (The derivation of this value follows the formula given in footnote a of table II.6-2 on page II-73 of EPTA (1988).)

(5) The fifth modification is silver, for which the highest AET has changed from 5.2 to 6.1 ppm in the 1988 Database. For similar reasons to those given for antimony, the ML will change to 6.1, but the SL will remain at 1.2 ppm because this is the mean reference area value, and there is no defined lowest AET in the 1988 data base. This change would adjust the bioaccumulation trigger value from 4 to 4.6 ppm.

(6) Arsenic will also be updated for reasons of programmatic consistency. The current arsenic SL and ML are 70 and 700 ppm, respectively. However, the new lowest AET is 57 ppm. This violates the rule that the SL should be less than the lowest AET. The SL only would be changed (to 57 ppm) because the highest AET has not changed. In comparison, the mean arsenic concentration in Puget Sound reference areas is 7.2 ppm. The guideline value for bioaccumulation would change from 511 to 393.1 ppm (see table A.8 in exhibit A).

(7) The sixth chemical considered is 1,2,4-trichloroethene (also called trichloroethylene). The ML for this chemical was based on the equilibrium partitioning approach (PSDDA. 1986. Development of Sediment Quality Values for Puget Sound. Volume 1. Prepared by Tetra Tech, Inc. and Resource Planning Associates for PSDDA and the Puget Sound Estuary Program). This publication states (p. 34):

> "The sediment-water equilibrium partitioning approach . . . involves plausible assumptions for estimating interstitial water concentrations of hydrophobic pollutants based on sedimentary concentrations. The toxicological assumptions require validation by comparison of calculated sediment quality values to observed site-specific biological effects."

The question considered by PSDDA was whether the information in Report ii, above provides better toxicological information than presently available in the program relating to site-specific environmental effects. Report ii states (on page 159):

> "Although toxicity information for trichloroethene was found for only freshwater organisms, it is interesting to note that a concentration of 1 ug/L trichloroethene resulted in reduced growth in black mollies (Poecilia sphenops)(Loekle et al., 1983). At this concentration and a calculated K_{oc} of 2.49, a sediment concentration of only 2.5 ug/Kg (ppb) could produce an aqueous concentration of 1 ug/L . . . . A sediment concentration of 2.5 ug/L1/ is well below the PSDDA screening limits2/ for trichloroethene (160 to 1,600 ppm). Any marine species which is sensitive to trichloroethene at a concentration of 1 ug/L or lower may not be protected by the PSDDA screening limits."

1/This should be 2.5 ug/Kg (ppb)
2/The values cited are the SL and ML.

The information presented relates to a nonmarine and nonindigenous species and is older than the 1986 marine acute criterion of 200 ppb, which was the basis for the PSDDA ML. Ecology's report on Contaminated Sediment Criteria discloses that trichloroethene is rare in Puget Sound sediments, and assesses the calculated results of artifically excluding it from sediment quality values in the Puget Sound Database. Removing trichloroethene resulted in no change in the reliability of the sediment quality values as a whole. In other words, the data currently in the Database on trichloroethene do not contribute to the identification of biologically impacted stations. Accordingly, the PSDDA agencies have decided not to modify the trichloroethene SL or ML at this time.

(8) The PSDDA agencies have decided to add butyltins to the PSDDA list of chemicals of concern for special "limited" areas, and to identify an interim SL and bioaccumulation trigger value. Tributyltin (TBT) is the most toxic of the butyltins. Butyltins' source in the marine environment is largely from use as antifouling agents in marine paints. TBT is also used to a lesser degree in certain industrial processes as a slimicide and plasticizer. TBT's distribution in Puget Sound is not well known. Tetrabutyltin, TBT, di-, and monobutyltins may be present in Puget Sound sediments at levels of potential ecological concern. However, TBT is thought to be present at significant levels primarily in inter- and subtidal areas and channels in urban bays and to a lesser extent in nonurban bays near marinas and shipyards where boat painting or other maintenance is performed.

PSDDA guidelines provide for designating a "chemical of concern in limited areas." Chemicals of concern for limited areas are described in EPTA (1988) (page II-85), and presently include guaiacols, chlorinated guaiacols, and chromium. These compounds have no SL or ML values because of limited information. Testing for these compounds is only required if regulatory agencies determine there is a reason to believe that a prospective dredging

area has a likelihood of their presence in significant concentrations. PSDDA agencies have adopted the butyltins as chemicals of concern in limited areas such as in the vicinity of active vessel maintenance. For the most toxic form, TBT, PSDDA agencies have adopted an interim SL based on equilibrium partioning, which is described in the following paragraphs. TBT data derived from PSDDA testing will be reviewed at least every 2 years in view of the source control and the potential for in-place degradation into less toxic forms. As with any of the PSDDA chemicals of concern, TBT could later be dropped if evidence shows this to be warranted.

New information was gained during Phase II. EPTA (1988), pages II-85 to II-87, discusses what was known of TBT during Phase I. During Phase II, PSDDA produced three reports and evaluated another.

> Report iii. Varanasi, U. et al., 1988. Analysis of Butyltins in Puget Sound Sediments--Initial Survey. (Report prepared by National Marine Fisheries Service for PSDDA.)
>
> This report describes chemistry results from limited sampling areas in Puget Sound and Lake Washington. The areas sampled were suspected of having high TBT levels, including navigation channels near marinas and shallow intertidal zones adjacent to boat maintenance facilities. TBT was found in shallow areas within and near marinas, and some elevated levels of the chemical occurred in areas with evidence of boat maintenance activity.

In EPWG's discussions of the report, it was stated that the techniques for quantitative analysis of TBT appear to be adequate for water, sediment, and tissues, and are within the reach of commercial analytic laboratories' instrumentation. The chemical assay technique cited in the report and the PSDDA baseline study is the specified preferred method for PSDDA. Analytic per-sample sediments testing costs for TBT are approximately $200-300 including laboratory quality control costs, based on current experience. This represents a potential cost increase of 5 to 10 percent for those samples in which TBT testing is required.

> Report iv. Cardwell, R. 1989. Aquatic Ecological and Human Health Risk Assessment of Tributyltin in Puget Sound and Lake Washington Sediments. Report prepared by Envirosphere for the Corps.
>
> This report interprets the data found in the above report using equilibrium partitioning and a number of other evaluative techiques. Recommendations in this report are:
>
> • PSDDA should adopt TBT as a chemical of concern in limited areas for a limited period of time. Laws and current practices are beginning to limit use of TBT paints in the marine environment. Substantial degradation of in-place TBT to less toxic species of butyltins or to inorganic tin should occur with time. TBT should be periodically reevaluated to see if it is necessary to continue special testing.

- For routine monitoring, a 48-hour sediment test using Pacific oyster larvae or a 96-hour test using a mysid would be suitable, based on these animals' high sensitivities to TBT.

EPWG considered that TBT and other butyltins would probably co-occur with other PSDDA chemicals of concern in paints, copper, cadmium, zinc, and organic chemicals. When such covariance occurs, the environmental protectivity of current evaluation guidelines should be relatively good. However, there is very little information in the Puget Sound Database from marina or boat maintenance areas. Current PSDDA tests include the recommended test species, a sediment test using larvae of the Pacific oyster. (The echinoderm larval sediment bioassay, alternative to the oyster larvae sediment test, is also expected to be sensitive to TBT.)

EPWG undertook the following steps arriving at an interim SL and bioaccumuiation trigger for TBT.

- Step 1. Environmental levels were examined at additional sites around Puget Sound.

New information also came from the following reports:

Report v. Puget Sound Dredged Disposal Analysis. 1988 (December). Baseline Survey of Phase I Disposal Sites Report. Report prepared by PTI Environmental Services for Washington Department of Ecology.

Report vi. Crecelius, E.A., D. Woodruff, and M. Myers. 1989. Reconnaissance Survey of Sediment Quality, Contaminants in Fish Tissue, and Prevalence of Fish Disease in Non-Urban Areas of Puget Sound. Puget Sound Notes, Spring, 1989.

As shown in the following table, TBT was found in four non-urban bays to range from 0 to 37 ppb dry weight, while urban bays and PSDDA baseline studies of disposal sites tested showed 1-400 ppb.

In addition, Report vii, below, indicates that the Port Townsend and Cap Sante marinas have elevated TBT levels (92-872 ppb at Cap Sante), whereas outside the marinas, levels were generally below 30-40 ppb.

Report vii. Crecelius, E.A., T.J. Fortman, S.L. Kiesser, C.W. Apts, and O.A. Cotter. Survey of Contaminants in two Puget Sound Marinas. Report prepared by Battelle for EPA Region X.

TABLE 5.2

SEDIMENT CONCENTRATIONS OF TRIBUTYLTIN IN PUGET SOUND.

Site:	TBT (ppb, dry wt, as Sn)	No toxicity: - Toxicity: +	Source
Commencement Bay	1.2-53 1/	amphipod -	Report v
Port Gardner	1.0-3.3	amphipod -	"
Elliott Bay	3.5-400 2/	amphipod - mussel+ 3/	"
Dyes Inlet	3-10	amphipod -	Report iv
Gig Harbor	17-37	amphipod -	"
Port Angeles Hbr	2.5-28	amphipod -	"
Oak Harbor	0-10	amphipod -	"

1/ Most were <4 ppb.
2/ Approximately seven stations >100 ppb.
3/ These mussel larvae data were reinterpreted from the PSDDA Phase I Baseline studies, although by the then-current standards they were considered to have failed performance limits. (For information on new standards for performance of the larval sediment test, see section 5.3 of this document.) With that qualification, the highest TBT sample with corresponding toxicity data, at 180 ppb, is a non-hit, but lower level values at 45 and 96 ppb are toxicity hits. These data are consistent with the statement in Report iv that bivalve larvae are thought to be more sensitive than crustaceans.

- Step 2. Professional judgment decisions being used in dredged material evaluation in other areas of the country were reviewed.

Professional judgment calls for initiating biological testing generally occur between 30 ppb and 100 ppb (Sandy Lemlich, San Francisco District, Corps, personal communication).

- Step 3. An equilibrium partitioning equation normalized to total organic carbon (TOC) was used to calculate interstitial water concentrations of TBT relative to sediment-bound TBT. Interstitial water concentration values were then compared to the EPA acute and chronic advisory values for water to suggest an interim SL.

The equilibrium partitioning technique and assumptions used for its application are described in Report iv, above.

If reasonable values are assumed for the equilibrium partitioning coefficient, K_{oc}, and for total organic carbon content, equilibrium partitioning indicates that bulk sediment concentrations of TBT should be less than 40 ppb to stay below a dissolved concentration of 0.531 ppb (ug/L). This value is the acute EPA water quality advisory value which would protect 95% of species.

Based on this information, a value of 30 ppb will be used as the interim SL for TBT. Thus, in limited areas of concern, where TBT is found to be greater than 30 ppb, biological testing would be required. There are no data that presently suggest an ML for TBT or an SL for other butyltins. Also, applying the "SL only" rule for human health described in EPTA (1988), p. II-73), the associated bioaccumulation trigger for TBT would be 7.3 * 30 = 219 ppb. There is, at present, no information available to provide an interpretive guideline (health index) in PSDDA for human health effects. Bioaccumulation values will be interpreted using best professional judgment and current information (for examples of such interpretations, see EPTA (1988)).

(9) Compounds specific to discharges from kraft paper mills: pentachlorophenol (PCP), tetrachlorophenol, polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF's).

The PSDDA evaluation procedures are revised to address compounds in areas which the State of Washington is designating (or will designate) as Clean Water Act 304(1) listed pulp and paper mills. This section of the Act deals with discharges of toxicants and the description of the waterbodies affected by the discharge. There are two presently considered for listing in Puget Sound, the Simpson plant which discharges into Commencement Bay and the Weyerheueser plant in Everett, which discharges into the Snohomish River. The following subparagraphs deal with the individual compounds or classes of compounds.

Chlorinated Phenols. PCP is already listed as a routine chemical of concern for dredged material testing under PSDDA, and has been reconsidered in light of the expanded Puget Sound Database (as discussed in paragraph 5.2 of Draft Phase II MPR). Although field information on PCP in Puget Sound is limited, the proposed Phase II establishment of an ML, reduction of the SL and bioaccumulation testing trigger together provide a means for addressing the environmental and human health risks of this chemical of concern. Accordingly, no further change is proposed.

Tetrachlorophenol is a suspected pulp mill effluent discharge chemical which has been found to co-occur with PCP and is a potential precursor chemical to PCDF's and PCDD's. The latter two classes of compounds are of concern because they are listed as human teratogens and carcinogens. (As described below, PCDF's and PCDD's are proposed to be addressed by PSDDA.) Since tetrachlorophenol has not been listed as a chemical of concern in any of the compendia of sediment chemicals for Puget Sound, and since the PSDDA evaluation procedures are directly addressing the co-occurring chemicals PCP, PCDD's and PCDF with the proposed revisions, there appears to be no reason to add tetrachlorophenol to the list of chemicals of concern.

Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans. PCDD's and PCDF's meet several of the PSDDA requirements for listing as chemicals of concern in dredged material. They are documented to be highly toxic, are persistent in the environment, may bioaccumulate in animal tissues, and are listed as human teratogens and carcinogens. EPTA (1988, p. II-87) outlined

the reasons for not including these compounds at that time on the list of general chemicals of concern, although nonchlorinated furans were included in the list of chemicals of concern. At the time, analyses for PCDD's and PCDF's in Puget Sound did not indicate their presence in several sediments otherwise contaminated with high levels of PAH's and heavy metals. The concern for toxicity was addressed in part by the demonstrated sensitivity of the PSDDA sediment quality values (SL and ML). That is, there are very few toxic stations in all of Puget Sound that are not correctly identified by the disposal guidelines for chemicals of concern (see EPTA, 1988, section II-7.2.3.3). This, combined with the apparent absence of these chemicals, high testing costs and uncertain analytical methods, led to the decision in Phase I not to include PCDD's and PCDF's on the list of chemicals of concern.

EPTA (1988) acknowledged that human health concerns for these chemicals are not fully addressed by the toxicity data. Recent data from kraft paper mills operating in Puget Sound indicate that PCDF's and PCDD's are measurable in fish tissues collected near the points of discharge. It is possible that sediments in these same locations may also contain measurable levels of these chemicals, although no sediment data were currently available from near the discharge points.

New information from EPA's (1989) National Bioaccumulation Study indicates concentrations of dioxin at or below 10 ppt in fish tissues near pulp mills in Puget Sound. There are numerous congeners of PCDD's and PCDF's with a wide range of toxicities. The toxicity equivalent concentration (TEC) is the usual means of expressing the realized toxicity. TEC sums the toxicity of the many congeners to equivalents of the most toxic congeners, 2,3,7,8-tetrachlorodibenzo-para-dioxin. TEC values from 7-1,000 ppt have been used as advisory levels. The revisions to the PSDDA evaluation procedures deal with potential human health concerns near the discharges by examining the bioaccumulation of the compounds into *Macoma* clams after their exposure to sediment. Should high levels (e.g., levels approaching the advisory level for pregnant women of 25 ppt) of the compounds be observed, it would be appropriate to consider human health effects of the material.

It is important to note that regulatory agencies are actively working to control and eliminate the discharge of these chlorinated compounds into Puget Sound and other Washington waters. Ecology and EPA are reviewing information to determine whether these compounds are present in the sediments and, if they are, to verify concentrations and distribution near known discharges from kraft pulp and paper plants.

Due to the lack of information on sediment levels of the compounds, it is not proposed to add them to the general list of chemicals of concern nor to the list of chemicals of concern for limited areas at this time. Both designations of chemicals of concern imply measurement of sediment levels, of which measurements are still exceedingly expensive and difficult; moreover, there is limited national laboratory capacity available for analyses. Also, the potential for sediment concentrations of PCDF's and PCDD's to result in tissue concentrations of marine organisms is being intensively studied by the

Corps and EPA, but results are not yet available to assist in interpretation of sediment data. The PSDDA annual review process provides the appropriate avenue for dealing with the new information resulting from these ongoing studies.

Pending definitive sediment data and definition of potential bioaccumulation relationships, it is proposed that dredging projects proposed for areas "in the near vicinity" of a Clean Water Act 304(1)-listed kraft pulp mill discharge will be required to conduct a 30-day bioaccumulation test using the Macoma bivalve, with tissue analysis for PCDF's and PCDD's. The definition of "in the near vicinity of a discharge" will be determined on a case-by-case basis by consensus of the PSDDA regulatory agencies after review of information on effluents, tidal currents and distribution of other compounds which move in the particulate phase (as would PCDF's and PCDD's).

Bioaccumulation testing of sediments where PCDF's and PCDD's are found or suspected in sediments provides direct evidence of potential tissue concentrations that could result from sediment and water exposure to these compounds. Chemistry data on tissues will be reviewed to determine suitability of the sediments for unconfined, open-water disposal. Information is emerging rapidly on human health risk levels for seafood tissue concentrations of these compounds. Tissue concentrations will be assessed using the best available information, including the risk analysis approach used with the PSDDA chemicals of concern and, once available, the predictive model for bioaccumulation of PCDD's and PCDF's currently being prepared by a joint Corps-EPA study (Dr. Victor McFarland, Corps' Waterways Experiment Station, personal communication). This model resembles that used for PCB's (see paragraph (9) below).

The use of Macoma bivalves in bioaccumulation testing offers two important advantages relative to other test species. First, this animal feeds in direct contact with the sediment, allowing a more direct exposure to sediment chemicals than either a mobile species or a sessile, filter-feeding organism. Second, unlike fish, bivalves have low ability to metabolize chemicals of concern, which facilitates direct detection of significant chemical levels in their tissues. Although there is no definitive study that relates bivalve bioaccumulation to fish bioaccumulation, these features of Macoma indicate it is an adequate surrogate for potential fish bioaccumulation.

(10) Polychlorinated Biphenyls (PCB) Bioaccumulation Trigger Value. The PSDDA evaluation procedures address human heath risk by requiring that bioaccumulation testing be conducted when a specified concentration ("trigger level") is exceeded in the sediment for any of the human health chemicals of concern identified in EPTA (1988). The tissue concentrations resulting from the bioaccumulation testing are interpreted using guidelines developed by application of standard EPA risk assessment procedures. Using these procedures and the resulting tissue guideline, the excess human health risk from PCB's in sediments deposited at PSDDA sites will not exceed a level of 10^{-5} (1 in 100,000). This level of risk is considered acceptable and does not merit revision. However, in light of recent information about the potential

bioavailability of organic chemicals in sediments, the trigger level for PCB's has been reconsidered to reflect the organic carbon content of the sediment, which is very important to the bioavailability of PCB's.

The risk analysis procedures used in PSDDA are detailed in EPTA (1988) section II-8.4. The human health risk analysis conclusions for PSDDA sites are necessarily different from those derived from other programs (such as Commencement Bay Superfund) dealing with shallow, nearshore environments. In shallower areas, fish are more abundant and more available for harvest. Different exposure routes occur in deep-water sites. PSDDA sites were also selected to avoid fishery areas and high concentrations of bottomfish and shellfish. The PSDDA risk analysis utilized available data regarding shoreline human consumption rates for bottomfish and the potential home-range of flatfish populations. Conservative assumptions were made to address the potential bioavailability of sediment PCB's at PSDDA sites. To add a margin of safety, the allowable chemical concentration resulting from the risk analysis was further reduced by about one third in defining the PSDDA tissue guideline.

The PSDDA agencies have concluded, based on the following calculations, that the current PCB tissue guideline of 1,790 ppb (dry weight basis) provided in the PSDDA evaluation procedures are protective of human health. However, as shown below, the trigger value is now normalized to total organic carbon (TOC).

The method used to derive the TOC-normalized bioaccumulation testing trigger level for total PCB's is provided in the following citation.

> Report viii. U.S. Army Corps of Engineers, Waterways Experiment Station. 1987 (March). Environmental Effects of Dredging, Technical Notes. Simplified Approach for Evaluating Bioavailability of Neutral Organic Chemicals in Sediment. Publication EEDP-01-8. Vicksburg, MS.

The method calculates a steady-state and worst-case "whole body" bioaccumulation potential (WBP) relating the tissue guideline (which is based on tissue lipid content) to the concentration of PCB's in sediment; it then derives a trigger level for PCB's in sediment.

$$WBP = 1.72 * (Cs/fOC) * fL$$

Where:

- Cs = sediment chemical concentration (dry weight)
- fOC = decimal fraction total organic carbon content of sediments (dry weight)
- fL = decimal fraction lipid content of animal tissue (dry weight)

Cs will vary by sediment as will organic carbon content of the sediment. The tissue guideline derived from the previous risk analysis was 2 ppm wet weight including the safety factor described in EPTA (1988, section II-8.4). Although fL will vary by animal and tissue, a conservatively high value of 3% lipids was assumed based on Commencement Bay RI/FS data indicating flatfish muscle tissues range from 2.1% to 3.1%.

Rearranging this equation,

$$Cs/fOC = WBP/(1.72 * fL)$$

The left-hand term is now the trigger value on an organic carbon and dry weight basis.

Using a WBP of 2 ppm wet weight and an fL of 3%, the following trigger level is obtained:

$$Cs/fOC = 2 \text{ ppm} /(1.72 * .03) = 38.76 \text{ ppm}$$

Rounding down (to add protectiveness), the bioaccumulation trigger is 38 ppm total PCB's on a carbon-normalized basis. This calculated trigger value is equivalent to the former trigger value of 1,790 ppb (dry) at about 70% solids and 3% carbon, both reasonable values for Puget Sound dredged material.

Material disposed on the PSDDA sites will be reviewed for toxicity during environmental monitoring, and bioaccumulation testing will be performed as indicated in 7.3.2.c of this report.

5.3. Clarification of bioassay testing procedures, performance standards and interpretive guidelines for: larval solid phase (bivalve or echinoderm) test, the 10-day juvenile infaunal species solid phase acute lethal bioassay (*Neanthes arenaceodentata*) test, Microtox, and the statistical interpretation of tests.

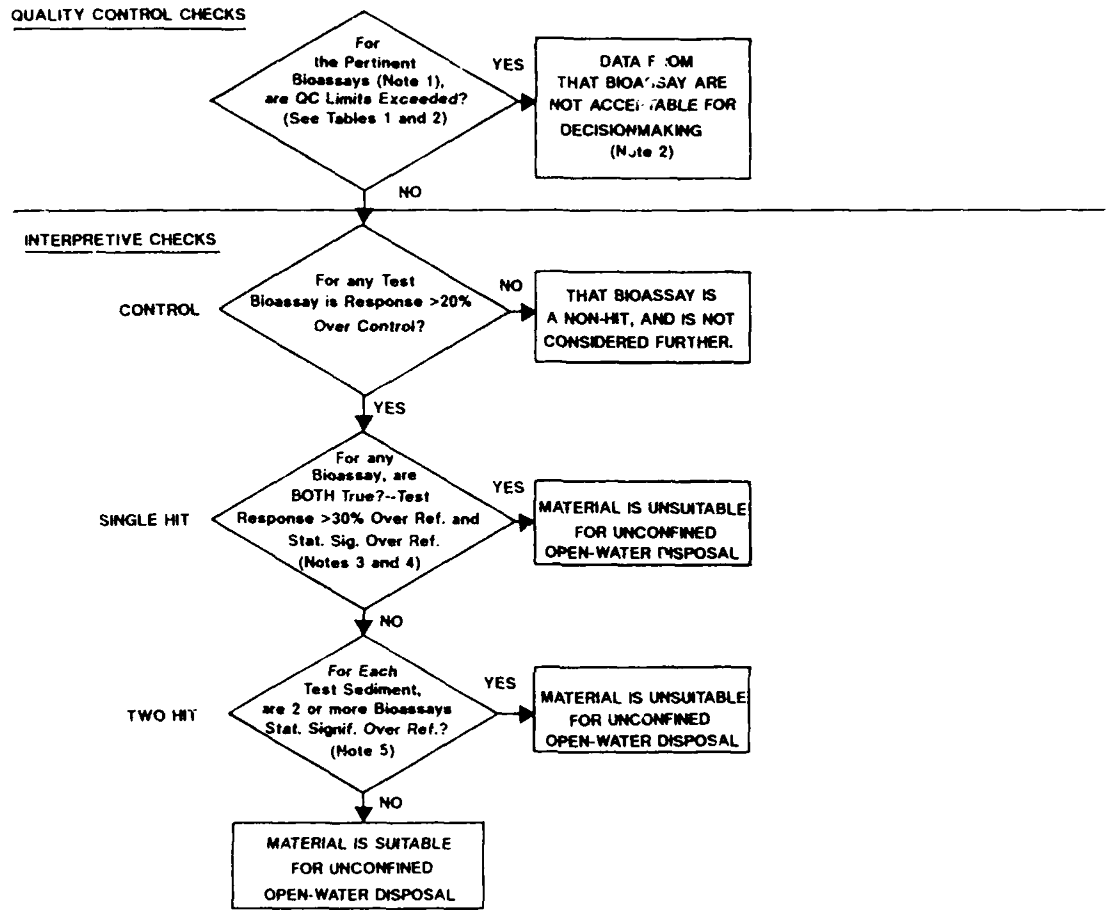
Several of the PSDDA bioassays are considered below based on the experiences gained since June 1988 with application to approximately six projects, EPWG discussions, and public input. The tests include bivalve (e.g., oyster) or echinoderm larvae as test organisms, the juvenile infaunal bioassay, and the Microtox bioassay.

a. Bioassay Decisionmaking Flow Chart. A flow chart clarifying and summarizing the PSDDA guidelines is displayed below. This chart and some of the terms (e.g., 404, 401 tests) are fully explained in exhibit A of this document, but it is reproduced now for reference in the following discussions of biological tests.

b. Bivalve and Echinoderm Larvae Solid Phase Bioassay. The June 1988 PSDDA procedures allow use of either oyster, mussel, or echinoderm larvae (EPTA (1988), pp. II-69, 70 and II-62). The PSDDA agencies have expended considerable effort since then to solve some problems which were noted during application to proposed dredging projects. These problems are characterized by low survivorship even in the seawater control due to bad spawning success, and in the reference sediment bioassays due to physical entrainment of larvae in exposures to fine-grained sediments, causing mortality not related to chemicals in the sediment.

TABLE 1 Control Limits, Amphipod and Juvenile Infaunal Species mortality $\leq$10% absolute. Larval Sediment Test T_{final} mortality plus abnormality in Seawater Control must be $\leq$50% of $T_{initial}$ Seawater Control.

TABLE 2 Reference Limits, For all Tests;$\leq$20% Over Control. In the Case of the Amphipod, >20% may be Accepted by the PSDDA Agencies on a Case-by-Case Basis for Sediments with High Fines.



NOTE 1 At this Step in the Flow Chart, the 404 Bioassays are Amphipod and Juvenile Infaunal Species; the 401 Bioassays include Those Tests Plus the Sediment Larval Bioassay. The 404 Water Column Bivalve Larval Bioassay is Not in This Flow Chart [Microtox, a 401 Test, Enters in a Later Step (Two Hit)].

NOTE 2 If any Bioassay Fails QC Limits, it Generally Must be Rerun, Unless the PSDDA Agencies Decide to Interpret Suitability Based on Remaining Test Results.

NOTE 3 Generally a Single-tailed Student's T comparison of Mean Test Sed. response versus Mean Reference Sed. response (Ho: they are equal), alpha level of $\leq$.05

NOTE 4 This decision block refers to Nondispersive Sites (Commencement Bay, Port Gardner, Elliott Bay, Anderson-Ketron Is. and Bellingham Bay). For Dispersive Sites (Port Angeles, Port Townsend and Rosario Straits),The Single Hit rule is >10% over Reference and Statistically Significant for the Amphipod and Juvenile Infaunal Species Test, and >15% over Reference and Statistically Significant for the Sediment Larval Test.

NOTE 5(This applies to Nondispersive Sites and the Two Hit case), Microtox is an additional 401 Test that Must be Considered at This Point. Microtox Results of the Test Sediments Must be Statistically Significant from Reference Results and >20% Below Control Response to Count as a Hit.

Figure 5.1 Summary of Biological Testing Requirements.

The Pacific oyster and the blue mussel are spring and summer spawners, but may be induced to spawn out of season. During 1988, there was considerable unexplained difficulty in getting adequate survivorship of fertilized eggs for testing using the oyster. The mussel and the echinoderm larvae were substituted with some success.

Poor survivorship in reference area sediment tests suggested the physical effects were problematic. Reference sediments are taken from areas of Puget Sound thought to be free of pollution sources and having sediment chemical concentrations at or below the SL values for chemicals of concern. They are used to closely match grain size with dredged material in order to separate biological responses to chemicals from responses to physical factors (EPTA (1988) II-6.2 and table 6.1). Several of these bioassay species are thought to be sensitive to fine-grained sediments.

As described below, the concept of a "sediment control" is not meaningful when applied to a planktonic larval stage. For PSDDA larval sediment tests, therefore, only a seawater control will be run. (This is a change from previous requirements.)

Information has been compiled by the PSDDA agencies on reference areas (see section 5.6) and on availability of spawnable adults of both the bivalve and echinoderm larvae for use by laboratories. The PSDDA agencies conducted an expert workshop on the sediment larval test on June 15, 1989, and, as a result of this workshop, have identified appropriate exposure temperatures and species, a calendar of availability, and means of identifying and inducing successful spawners at all times of the year. This information resulting from the workshop is available for permit applicants and their contract laboratories from the Corps.

Briefly, the larval sediment test consists of the following steps.

(1) the collection or acquisition of spawnable individuals of the species to be used;

(2) preparation of the individuals to spawn;

(3) spawning and fertilization check of the gametes;

(4) collection of seawater for use in testing;

(5) preparation of the seawater negative control (no toxicants added) and positive control series (several concentrations of a standard toxicant such as cadmium chloride);

(6) preparation of the reference sediment and test sediment vessels by shaking 20 g of sediment in 1 L of seawater;

(7) a period for settling of the sediments to form a layer at the bottom;

(8) inoculation of the fertilized eggs or developing embryos into the seawater negative control (the count taken at this time is called $T_{initial}$);

(9) a set period for exposure of the organisms, which is 48 hours for the bivalves and between 72 and 96 hours depending on the echinoderm species used;

(10) measurement of water quality during exposure (temperature, dissolved oxygen kept above 4ppm, etc.)

(11) termination of the test once it is expected that the transformation of the embryos has occurred to a distinct larval endpoint (the count taken of survivors and abnormals at this time is called T_{final}); and

(12) the enumeration and interpretation of the results.

Synopsis of changes recommended by EPWG and Sediment Larval Test Workshop. These changes represent departures from, or clarifications of the EPA Recommended Protocols requirements. These changes are presently only PSDDA programmatic requirements. It will be up to the Puget Sound Estuarine Program (PSEP) to determine whether to adopt these changes.

Species use, availability, and readiness to produce good spawn. The problems with determining which species to use, when they are ripe for spawning, and what constitutes a good fertilization response were addressed in the workshop by developing calendars of availability, lists of reliable sources, and guidelines for responsiveness. These are available on request from the PSDDA agencies. (Note that the Corps is a one-stop source of information for biological and chemical testing.)

Age of seawater to be used in testing. It was recommended by the experts that seawater for testing be less than 8 hours old at the time of inoculation replicates and preferably collected from deepwater or offshore water to avoid organic contaminants. (This is not an additional reporting requirement under PSDDA, but instead a recommendation to laboratories to improve performance.)

Minimum Number of Organisms to Count. The minimum count for larvae in the replicates should be 100 living larvae. All volumes counted should be reported. Previously, this was unstated in the PSDDA documents and the Recommended Protocols.

Performance limit guideline. The larval test is different from all other bioassays used in testing sediment due to the potentially high "normal" mortality during the exposure process. This is because larval stages have higher unexplained mortalities than do juveniles or adult stages of any organisms, perhaps due to more active metabolic transformations during growth. In consideration of this and discussion with experts, the PSDDA agencies have concluded that 50 percent mortality plus abnormality in the seawater negative control from $T_{initial}$ to T_{final} should be the absolute quality control limit;

however, it is anticipated that mortality of less than 30% should be achievable much of the time. Previously, the comparison for control limits has been done using the sediment (negative) control (usually clean beach sand) T_{final} over seawater negative control $T_{initial}$. Also, 30% mortality relative to $T_{initial}$ in the sediment control vessel and 10% abnormality were the quality control limits. This has not been a useful comparison and is unnecessary because of two changes, namely the correction for mortality to the seawater control at T_{final}, and the increased settling time (both of these are summarized in the following paragraphs). For PSDDA, it will not be necessary to run a sediment negative control, and control limits will depend only upon seawater negative control.

Time and conditions of test exposure. The larval tests were previously run at stated temperatures and times according to the Protocols. However, the experts noted that the local blue mussel was being run at too high a temperature and that the echinoderms did better at lower temperatures for longer times. Accordingly, the PSDDA agencies have determined to run the larval sediment tests near the optimal temperature of the larvae in order to avoid stressing them. "Target" time and temperatures are: oyster (20°C, 48h), blue mussel (15°C, 72h), sand dollar (12°C, 72h), and purple sea urchin (12°C, 72-96h). It is recommended that a duplicate, sacrificial seawater negative control be run, which is used for measuring population development to the desired larval stage (end point). Thus, the test exposure period could be variable, although the PSDDA agencies anticipate that it may be possible to achieve a standard time soon.

Adjustments for control mortalities during the testing. Partly as a result of running the test for different times as stated above, "resetting" or normalizing mortality to the final count in the seawater negative control is required to accommodate differential mortalities arising from the differing times of exposure between separate runs and separate test species. That is, the seawater negative control T_{final} count will be used as the 100% survivorship basis for test interpretation instead of the $T_{initial}$ count as was done previously. Normalization of control, reference and test data to T_{final} in the seawater negative control will mitigate the problem of mortalities over the $T_{initial}$ count; the performance limit is addressed in the "50% control limit rule" described above.

Definition of "normality." Recognizing that various regional laboratories have been using slightly differing versions of what constitutes an "abnormal" larva at the end of the testing period, PSDDA and PSEP considered the more specific definitions of normality presented at the Workshop:

Bivalve:

- An uninterrupted shell must be formed around the margin; any indication that the shell cannot close (e.g., chips or knobs) is abnormal. A judgment call may have to be made about open shells or shells seen in other than side view. Empty shells which are complete count as normal, because they developed successfully to the shelled stage, no matter what happened thereafter.

- Must have a straight hinge by termination of experiment. Should larvae not have reached D or prodissoconch I stage by the end of the exposure time (set by the duplicate sacrificial control vessel) they are considered abnormal.

Echinoderm:

- Clearly invaginated, with arms of pluteus distinct by the time that the duplicate sacrificial control has developed to pluteus.

This specification could result in some laboratories counting larvae as abnormal when they previously would have considered them normal. The PSDDA agencies will provide laboratories, on request, a series of photomicrographs or drawings that illustrate the proper interpretation.

Adoption of a standard settling time for sediments in the vessels. Problems were noted due to fine sediments which remain in suspension until after the inoculation of the eggs/embryos, causing them to be precipitated to the bottom of the sediment-containing vessels through physical entrainment or attachment of sediment particles to them. This can result in losses to the population measured at T_{final}, and a conclusion that mortality is occurring due to chemical toxicity in the reference and test sediment treatments when in fact the mortality is due to physical effects. Because of these problems and the suspected influence of sediment "conventionals," such as ammonia and sulfide, causing toxicity unrelated to the presence of chemicals of concern, the PSDDA agencies require a standard 4-hour settling time for the sediment slurry in all sediment vessels prior to inoculation of the fertilized eggs for all test species. (This was previously unspecified in the Recommended Protocols, and practitioners of the test used a variety of times.) The change should improve comparability of test results and minimize problems.

Scoring of Normal, Healthy Larvae and Abnormals. Previously in the PSDDA program, the mortality and abnormality measures were separate measurements, interpreted separately. However, in recognition that the abnormality measure could have a large "hidden" component represented by abnormal larvae that have ceased swimming and are in the sediment layer, alternative interpretations were suggested in the Workshop and considered by EPWG. Three alternatives were considered. (1) Count abnormals as animals that are not going to survive, so will be scored as dead. In other words, the abnormals will be counted, but interpreted as nonliving organisms. Thus, the measure of success becomes "healthy living larvae in the water over the sediment that have managed to change into the recognizable stage (D-shaped larva for bivalves, armed pluteus for echinoderms) and are not abnormal." (2) Count abnormals in the sediment layer. Abnormals are usually the only living larvae found in the sediment layer, but counting abnormals in the sediment would not be feasible. (3) Convert the test into an elutriate test (that is, use a sediment extract only, no sediment in vessel). Insufficient information is available to convert this solid-phase test into an elutriate test because intercalibration would be necessary to allow use of the results in the Puget Sound Database and assure compatibility to former testing data. A research proposal has been

formulated which could provide the needed intercalibration, and has been included with other Puget Sound research proposals. The PSDDA agencies decided to adopt the "normal and healthy" larva concept as the single measure for the sediment larval test.

PSDDA agencies also considered whether there is a need to adjust the test interpretation for dredged material to maintain the present degree of sensitivity. The concern is that, because currently the two measures are independent, subtracting abnormals from survivors in the water column would significantly diminish the allowable mortality under the guidelines. There is no logical reason to increase the sensitivity of the sediment larval test, which was shown to be highly sensitive and environmentally protective in EPA's Bioassay Intercomparison and in the Sediment Quality Values Refinement, Volume II: Evaluation of the PSDDA Sediment Quality Values (report i, cited above). The effect on regulatory interpretation of the new method of scoring living larvae was checked against several dredging project data sets. Using both the single- and multiple-hit rules and interpreting per the nondispersive guideline, very similar results were obtained with the new scheme of normalizing the combined measure of mortality and abnormality to the seawater control at T_{final}. However, it was recognized that high levels of abnormality associated with marginal survivorship could cause a hit to be scored under the new scheme, when the material could have been a "non-hit" under the former interpretation. To date in the program, high abnormality has generally been found when correspondingly high mortality has occurred.

Upon careful consideration, the PSDDA regulatory agencies have concluded that is appropriate to combine the mortality and abnormality measures, and to maintain the present interpretive framework for the larval sediment test. Accordingly, the nondispersive guideline for the sediment larval test would follow figure 5.1 and be:

- reference sediment $\leq$20% mortality over seawater control at T_{final}; and

- single hit rule: test sediment $\leq$30% over reference sediment and statistically significant (and >20% over control); or

- multiple hit rule: test sediment statistically significantly different from reference (and >20% over control).

For the dispersive guideline, where (as proposed in the draft Phase II MPR) a single hit may fail a sediment, and a hit occurs when the test sediment results are >10% over reference mortalities and statistically different as well as >20% over condrol, there is a much larger potential for abnormalities to cause failure of dredged material by adoption of the new counting scheme. Accordingly, the PSDDA agencies have changed the dispersive guideline for this test only from 10% to 15% for the test over reference limit for the single-hit rule. The larval test has a greater inherent noise than the other tests due to the large number of delicate animals, and so the minimum detectable difference is greater. The dispersive guideline for all other tests remains 10% over reference. Figure 5.2 illustrates the larval sediment test.

FIGURE 5.2

Nondispersive Guideline1/: Healthy Survivorship in Sediment Larval Test (Single-Hit)

Exposure Period:

$T_{initial}$
Stocking
Count

T_{final} Seawater
Control Count:
Set Equal to 100%
After Testing
Performance Limit

****

Exposure Period
variable (see text)

Interpretation: Mortality Combined with Abnormality Compared to Stated Sediment

Seawater Control	Reference Sediment No>20% (Absolute) over Control Sed. *	Test Sediment No>30% (Absolute) over Reference *

Mortality *
Performance Limit:
Combined Mortality
and Abnormality
Performance Limit:
$\leq$50% in Sediment Control
T_{final} over $T_{initial}$

1/The dispersive guideline differs: maximum interval between reference and test sediment for the sediment larval test, the maximum interval is 15%. For the amphipod and the juvenile infaunal species it is 10%.

Clarification of reporting requirements on positive control and percent water. The Recommended Protocols requires running of a standard toxicant, or positive control. This is also required under PSDDA, and reporting of an LC_{50} is an important cross-check on responsiveness of the test species. The calculation method used to determine the LC_{50} must be stated in the laboratory data sheets. Sodium pentachlorophenol is a standard toxicant stated in the Recommended Protocols. However, it is a potential human health risk in handling, and is discouraged for reasons of safety. Cadmium chloride or silver chloride are less difficult to handle and safer and are recommended. Results are required to be reported in terms of the metal ion, not as weight of the whole salt.

Reporting of Pore Water. It has been hypothesized that the mixing of the original sediment pore water into the larger volume of water accounts for the majority of the toxicants in solution to which the larvae are exposed during this test. In other words, the sediments were thought to be an unimportant source of soluble toxicants after settling. For this reason, the amount of dredged material pore water (approximated by the percent water measure reported for each sediment as a part of the conventional tests) will be considered by the PSDDA agencies during annual review evaluations of the sediment larval bioassay.

c. Saline Extract Microtox Test. This test requires clarification of its interpretation under PSDDA in view of recent experiences. Existing PSDDA and Recommended Protocols specifications potentially disqualifies many Puget Sound reference sediments from being used in this test for comparison in regulatory decisionmaking. The Phase I MPR (pages A-18 and A-23) states that a significant response for the saline Microtox test is a decrease in the test response (EC_{50}) of 20 percent (or more) below reference material EC_{50}, and further states that the Recommended Protocols' quality assurance/quality control procedures apply to the Microtox test. The Recommended Protocols state that there must be a determination of a significant dose-response relationship. However, many reference area sediments are non-toxic in the extraction range, and, therefore, do not show the required significant dose-response relationship. It is often not possible to make the comparison called for by PSDDA. The proposed change follows:

- First the dose-responsiveness of the saline test extract and reference extract would be determined using the Recommended Protocols specification for linear dose-response statistical significance. If there is no significant dose-responsiveness of the test sediment extract, the test result would be considered a "non-hit." (However, should the reference and test sediment mean responses at the highest concentration of extract be statistically different, this will be reported.)

- If there is a significant dose-responsive relationship established for the test sediment, five replicates of the highest concentration of the test sediment extract and five of the highest reference extract would be run. (It should be emphasized that the five replicates may be run with the dilution series, resulting in addition of only three replicates at the highest concentration to the testing requirement. However, if the additional replicates have to be run in a separate extraction series, five should be run together; because, owing to the time-critical nature of the test, the former run may not be statistically comparable.) Results should be expressed as blank-corrected percent decrease of luminosity.

- The mean of the reference and test values would be compared, and if they are statistically significant (alpha ≤ 0.05), a light depression of 20% or greater below the reference response would result in a reading of a "hit" for the test sediment. (This 20% critical response is the same level of difference that was adopted in Phase I.)

d. Statistical hypothesis testing of bioassays. Recent experiences have indicated a need for clarification.

In testing dredged material as management units which are to be characterized, the critical comparison being made is of the mean response to the test sediment from the management unit against the mean response to reference sediment. The hypothesis is --

> H_o: Mean test response is equal to mean reference response. (EPTA (1988) indicated an alpha level of less than or equal to 0.05.)

The most appropriate test is a single-tailed Student's T test. Testing for homogeneity of variances will be necessary before making this comparison, using Cochran's C-test. If variances of either test or reference are zero, a Mann-Whitney nonparametric test should be used. If variances are nonzero and rot homogeneous, the data should be transformed (arcsine-square root is used for percent mortaility data) and retested for homogeneity. If still nonhomogeneous, an approximate T test should be used.

Multiple comparison testing (e.g., ANOVA) is not appropriate in this case because the management units are being individually characterized, and the additional variation from other units, even should they be adjacent to the one being tested, is not germane to the comparison. In other words, we are not attempting to statistically compare the between-management-unit differences.

e. Organic Extract Microtox. The organic extract Microtox test was reviewed by EPWG, which recommended that the saline extract should remain the sole PSDDA Microtox test. The other PSDDA tests represent a direct exposure of test organisms primarily to soluble metals and relatively polar organic toxicants dissolved in a saline medium, similar to the saline extract Microtox test. However, the organic extract Microtox test measures a different group of sediment-bound, organically soluble toxicants whose bioavailability to sediment-dwelling animals is not well understood. The PSDDA agencies do not have sufficient information at this time to undertake a rigorous comparison of the results of the organic extraction to the saline extract test or other PSDDA bioassays, which would be highly desirable in order to evaluate these test results in the regulatory program.

f. Modification of the Organism Used in the Infaunal Species (Seed Clam) Bioassay. EPTA (1988) (II-67 through II-71, and exhibit E-11) states that the preferred species for the 10-day acute juvenile bivalve bioassay is the geoduck (Panope generosa), but that the native littleneck clam or Pacific oyster may also be used. The intent was to have a representative infaunal organism, preferably indigenous and commercially important. However, research and project-related experiences during Phase II and the implementation of Phase I surfaced problems (unexplainable mortalities in all treatments, including control and reference sediments) with the geoduck test. Also, it was recognized that there is no standardized protocol for the geoduck bioassay. Accordingly, the the test has been removed from the required PSDDA regulatory bioassays. An alternate organism such as the native littleneck seed clam could still be used. However, there is no reason to believe this species would be free of the problems besetting the geoduck test.

Although it is not an indigenous infaunal filter feeder bivalve (as is the geoduck), the cultivated polychaete worm, Neanthes arenaceodentata, has been adopted as the required PSDDA 10-day acute toxicity test. The species has been used in a regulatory program in California, and has been subject of research by the PSDDA agencies, so it is known to be a workable test. This organism is a juvenile burrowing infaunal deposit feeder, and has been identified by PSDDA as a promising candidate organism to employ in a future chronic sublethal test. The Corps has funded an acute lethal test demonstration using this organism to assure a workable protocol.

Report vii. Johns, D.M. 1989 (July). Test demonstration of a 10-day Neanthes acute toxicity test. Prepared for the Corps by PTI Environmental Services, Inc.

Neanthes represents an infaunal niche found in Puget Sound. Moreover, Neanthes has been used as a 10-day acute lethality bioassay in the Los Angeles area. (Although it is here called Neanthes arenaceodentata, the cultivated population of Neanthes from Los Angeles appears to be an as-yet-unnamed new species based on a different number of chromosomes from the Atlantic U.S. species. Virtually all of the physiological information in the literature is ascribed to this Los Angeles karyotype.)

The following paragraphs briefly summarize the testing protocol and interpretation for Neanthes arenaceodentata (Los Angeles karyotype). It should be emphasized that the protocol is still being developed, and will doubtless be subject to change. The worms are available from Dr. Donald J. Reish, California State University at Long Beach, and information is available from the Corps, Seattle District, regarding their culture.

The exposure system for Neanthes is the same as for the amphipod test, as detailed in report vii. It consists of a 1-liter vessel with an internal diameter of approximately 10 cm, which will contain sediment at a depth of approximately 2 cm overlaid by clean seawater to a depth of approximately 10 (additional) cm. Before adding the sediment to the container, its interstitial water salinity is adjusted by mixing with seawater to yield a final salinity of between 28 and 35 parts per thousand. Gentle aeration is provided via a micropipette. The vessels are loosely covered to prevent evaporation and atmospheric contamination. The vessels are kept in constant low light in a water bath at 20 degrees C ± 1 degree C. The control sediment is clean sand (e.g., West Beach on Whidbey Island, similar to the amphipod Rhepoxynius test).

The age of the test organism should be 2-3 weeks postemergence (that is, from the time that color in the coelom indicates the juvenile worm has begun to eat). The preferred handling treatment is to gently pipette the juvenile worms into the test vessel; a paintbrush may also be used, taking care not to dry the worms. Ten juveniles are placed in each vessel at the start of the experiment, with five replicates of each treatment, control and reference. The polychaetes are not fed throughout the exposure period. Static renewal will be used, consisting of changing one-third of the supernatant seawater

volume by gentle decanting at the end of the fourth and seventh days. Water quality is measured daily and should not exceed the following limits: dissolved oxygen (lower than 4 mg/l), pH (between 7.9 and 8.3), salinity (28-35 ppt). It is recommended for highly enriched sediments that ammonia be measured in the supernatant water in two test sediment-vessels without worms: one at the start and the other at the end of the experiment, and that the concentration not exceed 1.0 ppm of ammonia plus ammonium.

The duration of the test is 10 days. At the termination of the experiment, the test vessels' contents are carefully floated free from the sediment by immersing the sediment in a 500 um sieve and agitating in a pan of seawater. The surviving organisms are counted; it may be necessary to examine the tubes for survivors. The worms are aggressive, and living worms should respond to a poke from a paintbrush bristle.

Data will be presented as: raw survivorship in control, reference, and test sediments; statistical significance of each test mean versus the reference sediment mean (alpha $\leq$ 0.05); list of water quality parameters. The performance standards and test interpretation given in figure 5.1 and exhibit A.

5.4 Clarification of recommended procedures and limits of detection for organic compounds.

Low limits of detection (LOD's) are important for PSDDA data for consistency with associated programs such as the EPA's Sediment Quality Database.[1/] With some analytic techniques currently in use in the Puget Sound region, recommended limits of detection (LOD's) are not routinely achievable and may approach or exceed the SL's.

The rationale for PSDDA to adopt the 1986 EPA Recommended Protocols' LOD's was to achieve precision at the low concentrations of chemicals encountered in Puget Sound reference areas. However, the means by which the LOD's were

1/The Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (EPA, 1986) uses the term "Limit of Detection" in the manner used in this chapter of the MPR. At this time of writing, an update to the Recommended Protocols is undergoing peer review, and would change the definition after its adoption. In the proposed change, the term "Limit of Detection" would be based on the variability of the blank response in the analytical procedure, or upon the variability of the signal-to-background response when there is no detectible blank response. The proposed new term "Required Quantitation Limit" approximates what is meant by LOD in the current Recommended Protocols and in PSDDA. It is the maximum concentration of an analyte that may be reported without qualification as an estimated quantity. The Required Qualification Limit is based on the lowest concentration of the initial calibration curve, the amount of sample typically extracted, and the final extract volume of the method being used (R. Barrick, pers. comm.).

adopted, that is, as a range of precision for classes of organic compounds, failed to acknowledge that in some compounds the PSEP LOD's may exceed the PSDDA SL. PSEP's LOD's for semivolatile compounds (from EPTA, June 1988, p. II-108) are: for sediments (dry weight), 1-50 ppb; and for tissues (wet weight), 10-20 ppb. Table 5.3 (below) illustrates that the EPA Contract Laboratory Program (CLP) scope of work methods may follow this recommendation but still result in LOD's above the SL's. It should be noted that this table was set up to illustrate known problems with the cited technique; as explained below, most other chemical compounds measured in PSDDA do not have such analytic problems in CLP.

TABLE 5.3

SELECTED CLP LOD'S AND MODIFIED CLP LOD'S1/ AND PSDDA SCREENING LEVELS2/. Parts per billion.

	CLP	Modified CLP	Current PSDDA Screening Level
Phenols			
4-methylphenol	330	50	10
Pentachlorophenol	1600	250	69
Chlorinated Hydrocarbons			
1,4-dichloro-benzene	330	50	26
1,2-dichloro-benzene	330	50	19
1,2,4-trichloro-benzene	330	50	6.4
Hexachlorobenzene	330	50	23
Miscellaneous Extractables			
Benzyl alcohol	330	50	10
Benzoic acid	1600	250	216
Dibenzofuran	330	50	54
N-nitrosodiphenyl-amine	330	50	22

1/Araki, Roy 1988. Major Concerns of the Manchester Environmental Laboratory on the Use of the Puget Sound Guidelines.
2/Exhibit A, table A.8.

CLP is a method which is in common use at local laboratories because of its use in solid waste characterization. Modified CLP is a variation which increases by 2-3 times the amount of sample that is extracted for analysis, and also concentrates the extract to less volume. Both inprove the detectibility of organis compounds. Another method, stable isotope dilution,

which is more precise and expensive than the foregoing, is described in the proposed revisions to the Recommended Protocols. For those compounds with stable isotopes, this technique will readily achieve PSDDA SL's. Regulatory agencies have been informing permit applicants about the possible problem of achieving SL's while using some standard CLP methods for the listed compounds. A particular concern has been raised for standard CLP methods for organic extractables which, during the dehydration step before addition of the extracting solvent, could lose some of the more volatile extractable compounds (e.g., EPA extraction method 3550). Laboratories should note that the Recommended Protocols suggests adding matrix spikes after dehydration steps. This can result in a quality control failure under PSDDA. Matrix spikes should be added before dehydration to correct for possible losses.

The PSDDA agencies have concluded that it is recommended that LOD's meet Recommended Protocols' specified ranges, but that analyses of specific organic compounds are required to result in quantitated or detected values below the SL for each compound. Stable isotopic dilution is strongly recommended for compounds for which a stable isotope is available, along with the associated quality assurance and quality (QA/QC) control specifications in the Recommended Protocols. The modified CLP method is acceptable, providing specified LOD's (at or below SL's) and quality assurance steps are met. An important quality assurance step for PSDDA is the running of an analytic sediment reference material for which all extractable organics have been well characterized.

A concern has been raised that high prices are being asked by local laboratories to reach LOD's consonant with the SL's. The cost analyses given in EPTA (1988) assumed use of stable isotope dilution.

5.5 Clarification of Metals Extraction Procedures and Associated Limits of Detection.

For chemical testing of sediment samples, metals must be extracted prior to quantitative analysis. EPTA (1988) (pages II-104, II-107 and table II.7-2) recommends the Total Acid Digest (TAD) method for extraction using hydrofluoric acid and aqua regia. All mineral-bound metals are made available for instrumental analysis. However, a second technique, the Strong Acid Digest (SAD), is also allowed. For this procedure, the sediment is digested using nitric acid and hydrogen peroxide, then refluxed with nitric or hydrochloric acid. The SAD procedure does not break down all mineral (matrix) components. TAD has an advantage of being more reproducible among different laboratories, but it also has some disadvantages.

Advantages of the TAD:

- comparability among data sets is improved (i.e., variable extraction efficiency due to variable grain size or sediment matrix effects is eliminated);
- reference materials can be included as an element of quality assurance (not always comparable with strong acid digest because metal extraction is incomplete); and

- potential loss of volatile metals during digestion is minimized by using an enclosed digestion chamber.

Advantages of the SAD:

- matrix interference during atomic absorption (AA) analysis is less of a problem than for total digest; and

- laboratory safety is improved (i.e., digestion bombs and hydrofluoric acid, which are used for total digest, are not used for strong acid digest).

EPA's Recommended Protocols recommended LOD's[1/] based on the SAD method, which were adopted by PSDDA (see EPTA (1988) p. II-107, table II.7-2 and table 5.4 below). These LOD's are achievable with the SAD method but may not always be realistically achievable with the TAD method. (The reasons for this are matrix interference problems and method-imposed sample size limitations in the TAD protocol.) It is important to note that these metal LOD's in question are generally well below the PSDDA SL's. The problem is one of being able to detect metals in Puget Sound reference areas.

As part of the first annual PSDDA review, the most recent program data was examined to determine whether the recommended TAD method should be retained, and what the associated quality control and LOD's should be. Considerations included adopting the SAD method at the recommended LOD's, adopting the TAD with higher LOD's, and modifications to TAD technique that could lower the LOD's.

Discussions with several local laboratories have indicated that the Recommended Protocols' LOD's may be approached and achieved for most of these metals if the sample size extract is increased and quality control is increased using reference materials.

The decision was made to strongly recommend the TAD method with the following modifications:

- extracted sample size would be increased from 0.2 to approximately 0.3 grams to provide a stronger signal;

- reference materials should be run using the matrix matching technique for quality control; and

- the associated LOD's for this technique must fall within a factor of 2 of the Recommended Protocols' LOD's cited in table 5.4 and in Phase I EPTA (1988).

The use of SAD will be discouraged. However, the dredger may still propose its use provided that equal or better performance and quality assurance comparable to the TAD protocol is achievable by the testing laboratory.

1/See footnote on page 5-27.

TABLE 5.4

ACHIEVABLE LIMITS OF DETECTION FOR METALS IN SEDIMENTS BASED ON THE TOTAL ACID DIGESTION TECHNIQUE (RANTALA AND LORING, 1975)

Metals	Routinely Achievable LOD's 1/ mg/kg dry wgt	Current PSEP LOD's mg/kg dry wgt	PSDDA SL(as modi-fied in Phase II)
Antimony 2/	1.0	0.1	20
Arsenic 3/	2.5	0.1	57
Cadmium 3/	0.25	0.1	0.96
Copper 3/	1.0	0.1	81
Lead 3/	0.5	0.1	66
Nickel 2/	0.5	0.1	140
Silver 2/	0.15	0.1	1.2
Zinc 2/	1.0	0.2	160
Mercury 4/	0.01	0.01	0.21

1/Personal communication, Dr. John Lunz, SAIC, 1988.
2/ML set by TAD in 1986 Puget Sound Database.
3/ML set by SAD in 1986 Puget Sound Database.
4/Cold Vapor AAS technique (PSEP Protocol for Metals)

Three metals, arsenic, cadmium, and lead, have 1986 SL's and ML's based on the SAD method (table 5.4). A concern has been raised that the TAD method could yield a false positive result for these metals. That is, the metals could exceed SL's or ML's due to the higher extraction efficiency of the TAD when, had SAD been used, they would not have exceeded the values. The PSDDA baseline study (Report v, above) compared metals concentrations in sediments, and confirmed that TAD has a higher extraction efficiency than SAD for the kinds of sediments in Puget Sound. Many of the method-imposed differences were less than 30% and fell within the analytical variability set for the method of quantification. Because the usual limit for precision relative to a reference materials or standardized reference sediments is 30%; it is believed this should be achievable with SAD in most cases. However, some were outside of this range, and the report notes that matrix effects at the low end of the concentration ranges (below the SL) may result in lower TAD-estimated concentrations than SAD for lead and arsenic. In recognition of this information, PSDDA agencies will cautiously evaluate results of analyses near the SL and ML concentrations for these three metals.

5.6 Clarification of amphipod bioassay reference stations and performance standards.

PSDDA specifies a maximum allowable mortality of 10% (absolute) in the control sediment and 20% (absolute) in the reference sediment over the control sediment for the amphipod test. That is, when control mortalities exceed 10% or when the reference mortalities exceed 20% over control, the test would have to be rerun. Should there be, for example, a 10% mortality in the control treatment, the absolute mortality in the reference treatment cannot exceed 30%. However, it is not possible at this time for PSDDA to confidently specify to the dredger all sampling locations of chemically and toxicologically "clean" reference sediments. Rerunning of reference bioassays would add significant expense and delays. Higher mortalities than 20% are reported from some Puget Sound reference areas.

PSDDA agencies are attempting to solve the problem by two means. First, they are compiling information to better define reference areas. Dredgers that do biological testing are asked to provide reference station latitude and longitude so that areas may be better documented. Second, Federal projects are being asked to run chemistry on reference areas as well as biological tests. Third, Ecology and EPA have also funded a reference area study which summarizes data from around Puget Sound.

Ecology and EPA have recently located and chemically and biologically characterized a shallow and accessible reference area located in Carr Inlet (north of Raft Island), near Kopachuck State Park. Chemistry data available on this area indicate it is unpolluted and has a range of grain-sizes from <10% to nearly 95% fines. A rapid method of field-estimating percent fines has also been devised, which can be done in a small boat and requires 15-20 minutes per sample. It uses wet sieving of collected sediments through the standard 63-micron mesh sieve used for dry sieving to determine percent fines, followed by observing settled volumes of fines. A calibration curve is being prepared for the wet-to-dry conversion so that it should be possible to approximate test sediments in the field. Bearings by latitude/longitude, compass, variable range radar readings, and LORAN-C lines of positioning are available, so that it is possible to revisit particular stations.

The second means of resolving reference area problems is to consider the literature relating Puget Sound reference areas to the amphipod test, and considering changes to the quality control of the test. The following report has recently been published:

Report ix. Pastorok, R. A., R. Sonnerup, J. J. Greene, M. A. Jacobson, L. B. Read, and R. C. Barrick. 1989 (June). Performance Area Standards for Puget Sound Reference Areas. Draft report submitted by PTI Environmental Services, Inc., to Ecology.

It examined data from 12 potential reference areas in 13 total surveys. A broad range of mean percent mortalities was observed. For example, Dabob Bay had 7-36% mortality, Port Susan had 10-37%, Samish Bay had 20-47%, and Sequim Bay had 6-37%. The distribution of mean mortality values exhibited a primary

mode at 11-13%, a secondary mode at 23-25%, and a 95th percentile of mean reference area mortality equal to 43%. Case Inlet, Samish Bay and Possession Sound exceeded the 95th percentile.

This wide range of mortalities could be explained by the hypothesis that the mortality results are strongly influenced by some other factor than chemical toxicity in reference area sediments. The reference below supports this hypothesis:

> Report x. Dewitt, T.H., G.R. Ditsworth, and R.C. Schwartz. 1988. Effects of natural sediment features on survival of the phoxocephalid amphipod, Rhepoxynius abronius. Mar. Environ. Res. 25:99-124.

This report indicated that the cause of amphipod death is reference sediments with a preponderance of fine-grained particles is probably due to physical events such as interference with respiration and feeding mechanisms and not chemicals in the sedimentary pore water. It derives an empirical equation for predicting maximum mortality that may be expected (at 95% confidence) to occur without chemical toxicity in the range of 0-100% fines. At 10% fines, a maximum of 22% mortality could occur in the reference material; at 50% fines, approximately 33%; and at 98% fines, approximately 46%.

The PSDDA agencies have considered the following options for the interpretation of the Rhepoxynius reference and test performances. First, the elimination of a performance standard was considered. The comparison of test sediment mortality to reference sediment mortality is the critical determination made during this test, and it would not be appropriate to allow unlimited mortality in reference sediments. Second, PSDDA considered raising the allowable mortality to the maximum 95% prediction limit of approximately 46% across all grain sizes. This has the same problem as removing the limit. The third option was to interpret the amphipod test using the 95% prediction limit. This would be difficult, for every increment of percent fines would have a different associated reference limit; also, it is not clear how precise the relationship is. The fourth option considered was to disqualify the amphipod test above a particular percent fines, interpreting the results of the testing based on the remaining bioassays. However, experience to date in the PSDDA program is that the high "nontoxic" mortality only occurs occasionally in finer grain size sediments. The fifth option was to remove the limit for having to rerun the test, but to give a maximum allowable value of 25% mortality in the reference sediment for the sake of the comparison to test sediment (this was the option presented in the draft MPR).

The PSDDA agencies have decided that 20% (the former control limit) will be retained, but if it is exceeded, will not necessarily result in having to rerun the amphipod test. In that case, percent fines will be examined and predictions from Report x taken into account with other published information available. A determination will be made whether significant toxicity has occurred in the reference sediment. Should the PSDDA agencies determine that it has, the amphipod test should be rerun.

Also, PSDDA strongly encourages a close grain size match between reference and test sediments. The location of a reliable reference area mentioned above should make this feasible. It is adviseable to use the Raft Island reference area or others where there is information available on ranges of mortality expected.

By gaining better knowledge of Puget Sound reference areas and performance of the test, it is anticipated that physical factors interfering with the interpretation of the amphipod test will be minimized.

5.7 Sampling plan clarifications: recency guidelines, achiving sediments for post-dredging surface elevations, and debris reporting.

Recency guidelines. A flow chart is presented as figure 5.6 and in exhibit A to clarify the relationships of the recency guidelines. It does not represent a change, but instead clarifies statements made in different parts of EPTA (1988).

Project sampling to assess post-dredging surfaces and archiving for analysis. EPTA (1988, page I-14) and the Phase I MPR (page A-12) are not totally consistent with regard to this subject.

First, this requirement is primarily for areas that have groundwater contamination, such as occur in some high-ranked areas. The concern is that the surface left exposed after dredging would be more contaminated than the previous surface. No archived samples would be required for example in dredging done in order to construct a trench for laying a pipe, since sloughing would quickly cover the exposed surface.

Second, archiving in this case would only apply for subsequent analyses to organic semivolatiles and metals, and the holding time for mercury would be relaxed in this case. This is needed because of the relatively short holding time for the organic volatiles and mercury specified in the Recommended Protocols: the holding time for volatiles (14 days), mercury (28 days), and sulfides (7 days) would otherwise constrain the dredger to do chemical analyses on the archived samples before the results of the other tests are known. The longest chemical holding time before analysis based on this clarification would be 6 months due to limits for holding of particle size, total solids, and metals analyses. (Biological testing would not be required of these sediments since the comparison being made is to predredging chemical levels.)

Reporting of debris on the project site as part of the sampling plan. The PSDDA agencies have determined that debris occurring at the project dredging area and which is of a size that could cause fouling of fishing nets should be reported as a part of the proposed dredging and disposal operating plans (see sections 6.1 and 6.2.7). The means of removing debris from the dredged material will be explicitly addressed by the dredger. This is an added requirement which will assist the PSDDA agencies to determine that debris removal has been accomplished.

5.8 Dispersive Site Disposal Guideline.

Disposal guidelines at the nondispersive sites (Bellingham Bay, Anderson/Ketron Island) are the same as for Phase I (Phase I MPR, June 1988) and as modified by the Phase II MPR. However, at the dispersive sites (Rosario Strait, Port Townsend, and Port Angeles), monitoring disposal site conditions and disposal practices is much more difficult and costly because the dredged material rapidly moves offsite due to energetic currents. Dilution and dispersion should quickly reduce the concentrations of chemicals from dredged materials discharged at these sites, thereby reducing the potential for adverse biological effects. The PSDDA agencies considered the difficulty in predicting the fate of the material at dispersive sites. Because of the very high cost of field verification studies, a more restrictive guideline was established for the dispersive sites. Table 5.5 summarizes the Dispersive Guideline.

5.9 Area Rankings for Phase II Areas.

PSDDA uses area rankings to establish sampling and compositing schemes for characterizing sediment chemistry and biology. Exhibit A, table A.1, has been expanded to include initial area rankings for dredging areas in the Phase II area.

TABLE 5.5

COMPARISON OF DISPOSAL GUIDELINES FOR PHASE II SITES

Testing	Nondispersive Guideline	Dispersive Guideline
Chemical	As in Phase I (modified by Phase II) 1/	As in nondispersive guideline
Biological Test Species	As in Phase I (modified by Phase II) 2/	As in nondispersive guideline, except Microtox not used
Performance Guidelines	As in Phase I (modified by Phase II) 3/	As in nondispersive guideline
Interpretive Guidelines:		
Two-hit	As in Phase I (see figure 5.1)	As in nondispersive guideline
Single-hit	For amphipod, juvenile infaunal species or sediment larval bioassay: any one bioassay mean response statistically significant, greater than 20% over control, and greater than <u>30% over reference</u>	For amphipod and juvenile infaunal species, any one bioassay mean response statistically significant, greater than 20% over control, and <u>greater than 10% over reference;</u> for larval sediment test, as above, but <u>greater than 15% over reference</u>

1/The chemical changes are specified in this chapter, section 5.2.
2/The addition of <u>Neanthes</u> as the test for juvenile infaunal species has also been made in this chapter, section 5.3.
3/The two changed performance or quality control guidelines are: amphipod (section 5.6) and sediment larval (section 5.3).

5.10 Status of the Chronic Sublethal Test.

Chronic sublethal effects may not result in mortality to an organism, but instead produce changes to the organism during its life (e.g., behavioral changes or growth depression) or to its reproductive success (e.g., reduced numbers of fertilized eggs or effects on the next generation of the organism). This section describes what has been done in developing such a test but does not propose a new test for use at this time; prospective regulatory application of a specific bioassay is currently being discussed by the PSDDA agencies.

a. Need for a Test. The need to consider chronic sublethal effects from chemicals which could be present in sediments proposed for open-water disposal is identified in the 404(b)(1) Guidelines and in State laws.

b. Consideration of Chronic Sublethal Effects in the PSDDA Evaluation Procedures. During Phase I PSDDA chemically-caused chronic sublethal effects of dredged material at disposal sites were considered (EPTA (1988): ES-13 and 14, II-74, and II-218; Phase I MPR: 5-7 and 5-10). The definition of "minor adverse effects" on biological resources due to chemicals of concern in sediments provides that some species at the disposal site could be affected in the long term, but that only sublethal effects are anticipated. Additionally, EPTA (1988) (ES-16) states, "Aquatic effects associated with disposal of material under Site Condition II guidelines could include sublethal effects at the disposal site and potentially a small (though not significant) increase in the mortality of the more sensitive, but less abundant, benthic infauna (e.g., crustaceans)."

Although the PSDDA agencies believed that the chemical and biological tests addressed these stated biological effects conditions, they determined to seek a chronic sublethal test to assure that these effects were measured. No reliable and available chronic sublethal tests were found during Phase I that could be used to assay potential chronic sublethal effects of dredged material. Accordingly, PSDDA agencies concluded that further efforts should be spent during Phase II in developing such a test. (The efforts are given in d, below.)

Currently, PSDDA evaluation procedures permit some assessment of chronic sublethal effects through the existing suite of sensitive acute toxicity bioassays and bioaccumulation tests. EPTA (1988) (II-74) states, "Pending development of an appropriate sublethal bioassay, assessments of sublethal effects of dredged material will depend on the other biological indicators already recommended as evaluation tests: abnormality in the bivalve larvae and echinoderm embryo bioassays, sublethal effects in the Microtox bioassay, and use of Apparent Effects Thresholds . . . based on benthic infaunal abundance for in situ sediments (i.e., at the dredging site). While none of these indicators is adequate to independently assess the effects of concern, they combine to provide a weight of evidence that is useful in the interim in characterizing potential sublethal effects." The Phase I MPR (5-10) states ". . . the proposed suite of biological tests, in concert with the chemical disposal guidelines, are considered the best available at this time, and fully adequate to assess the possible effects of sediment chemicals of concern."

c. Results of a recent, independent review of the protectiveness of PSDDA guidelines for chronic sublethal effects. Recently a report was published that suggests that the PSDDA sediment quality values are generally protective of marine species as regards chronic sublethal effects at PSDDA sites, but also highlights the lack of a chronic sublethal bioassay. Report ii, described under section 5.2, proposed a conceptual framework for chronic sublethal effects at PSDDA nondispersive sites.

The framework interprets the intent of the PSDDA agencies in dealing with chronic sublethal effects based on discussions with PSDDA representatives. The framework follows in paraphrase:

(1) Chronic sublethal effects definitions are numerous and difficult to agree upon. To PSDDA, the meaning is both long-term and sublethal effects.

(2) During site use, onsite physical effects due to disposal (dredged material falling and smothering) are considerably greater than potential chronic sublethal chemical effects. Non-mobile fauna will be buried by dredged material and full recolonization of the site will not be likely until after the site is permanently closed. During inactive periods, chronic sublethal effects may occur to organisms, and are allowed under Site Condition II (the nondispersive guideline).

(3) During site use, the PSDDA agencies intend that neither non-mobile organisms living near the site nor mobile predator species visiting the site should experience chronic sublethal effects due to chemicals disposed on the site. An example of such an undesirable effect is cancerous lesions caused by bioaccumulated chemicals in bottomfish feeding on benthic organisms at the site.

(4) When the site is closed (perhaps after 40-50 years), the PSDDA agencies intend that recolonization of the site could occur by benthic species to a bottom community that is within the range of natural variability of regional unimpacted bottom communities; and that no mobile visiting species would suffer effects as in (3).

This framework will provide the basis for discussions at the second PSDDA annual review meeting.

The report analyzed a specific project which is proposed for disposal at a Phase I PSDDA site, and determined effects per the framework. On the basis of assessment of benthic community composition at the dredge and disposal sites; a wide-ranging literature review of dredging effects including ecosystem, community, organismic, tissue-level, cellular and subcellular effects; equilibrium-partitioning calculation of soluble toxicants from sediment; and best professional judgment, the report concluded that the project would not cause more than minor adverse effects, including chronoc sublethal effects on biological resources due to sediment chemicals. It also concluded that effects would be within the proposed conceptual framework.

PSDDA chemicals of concern were specifically examined for potential effects, and categorized according to a contaminant classification (McKay, D. 1988. On low, very low, and negligible concentrations. Environ. Toxicol. Chem. 7:1-3). This classification offers PSDDA agencies a useful tool to prioritize chemicals of concern for consideration in the annual review process. Contaminants may be categorized in three categories which indicate severity of potential environmental effects: disruptives, which exert nonselective or narcotic effects due to their quantity instead of any potent biochemical

properties; distributives, which are biochemical agents with marked effect which have minimal or no effects at low concentrations; and directives, which are of sufficient potency that they may cause severe reactions even at low concentrations. Directive chemicals that are based on known chemical activity amidst the PSDDA chemicals of concern comprise most of the high molecular weight polycyclic aromatic hydrocarbons (PAH's), hexachlorobutadiene, and n-nitrosodiphenylamine. Distributive chemicals are lead, PCB's, hexachlorobenzene, the phthalate esters, and the pesticides. The majority of the remaining chemicals are disruptives, although most of the low molecular weight PAH's and several of the high molecular weight PAH's may be insufficiently characterized to classify at this time.

The report examined the protectiveness of PSDDA chemical criteria for chronic sublethal effects. Both acute toxic and chronic sublethal effects of the PSDDA SL's and ML's were considered, but the emphasis was on the values from the literature that show chronic and sublethal responses, and which generally occur at lower levels than acute toxic effects. Equilibrium partitioning was then used to estimate the minimum sediment bulk chemical levels that would produce a chronic sublethal response in the aqueous phase, and these levels were then compared to the PSDDA SL's and ML's.

The report concludes that, for the 42 of 58 PSDDA chemicals of concern for which an equilibrium partitioning coefficient could be calculated, the PSDDA SL's are protective of marine species against both acute toxic and chronic sublethal effects at the disposal sites, with one exception. Excluding that exception, the equilibrium-partitioning-derived sediment concentrations exceeded the PSDDA ML by a factor of from 2 (in alpha-chlordane) to 10^9 (in bis[2-ethylhexyl]phthalate). The exception is 1,2,4-trichloroethene, a directive chemical. (The information on this chemical is reviewed in section 5.2. which notes that it is rarely encountered in Puget Sound sediments and that the Puget Sound Database manipulations have implied that, when it is found, it did not contribute to the statistical identification of Puget Sound impacted areas, implying that it is not acting as a singular toxicant in the dataset.)

Regarding existing PSDDA bioassays, the report notes a diversity of opinion amongst experts on the ability of the existing PSDDA tests to predict chronic sublethal effects: some experts felt that some information on chronic sublethal effects could be determined by the acute sediment toxicity tests, while others stated that a wider range of tests are needed. Specific criticisms included: (1) there is a lack of pertinent information on "directive" chemicals such as PAH's, whose effects are more likely to be seen in long-term exposures; (2) there are few measures in the suite of tests which may be interpreted for chronic sublethal effects in an ecological (e.g., benthic community) mode; and (3) there are a wide range of chronic sublethal effects that are not addressed by the present PSDDA tests (e.g., growth and reproduction).

This independent review supports the PSDDA agencies' conclusions regarding chronic sublethal effects stated in (b) above: allowable chemical levels take those effects into account and appear to be consistent with the selected biological effects condition, existing biological tests consider some (but not all possible) chronic sublethal effects and it is still desirable to develop a test to measure chronic sublethal effects.

d. Status of Development of Chronic Sublethal Test. The PSDDA agencies, as stated above, recognize the need for a chronic sublethal test. Despite the efforts made during Phase II (which are summarized in the next paragraph), no regulatory test is available for assessing chronic sublethal effects. A promising organism and an interim protocol for test development have been selected as the result of Phase II studies and an expert workshop held in late February 1989 by Ecology. Research is currently being performed to further develop the test, and it is hoped that it will be available for use in a regulatory mode when consistent results are available from local laboratories and when interpretive guidelines are documented and agreed to.

The PSDDA agencies agree on the need for a test, that the selected organism (Neanthes arenaceodentata) is the best available one at this time, and that it is worthy of further research. Ecology is evaluating the ability of the draft protocol to provide consistent information, and has stated that it is considering application of the test on a preliminary, case-by-case basis under its CWA Section 401 authority. The PSDDA agencies have not yet agreed that the test may be interpreted in a regulatory application. The present set of sensitive acute lethal bioassays will continue to be used as surrogate indicators for chronic sublethal effects until the test has been fully developed and appropriate disposal guidelines formulated in order to make decisions on the acceptability of dredged material for discharge at the PSDDA disposal sites.

e. Events Relating to Chronic Sublethal Test Development During Phase II. PSDDA funded test development of two high-potential species to obtain a chronic sublethal bioassay.

Report xi. Johas, D.M., 1988. Puget Sound Dredged Disposal Analysis: Sublethal Test Demonstration. Prepared for the Corps by PTI Environmental Services, Inc

Three tests were performed:

- A 20-day biomass increase test was done using the polychaete Neanthes arenaceodentata. (The 20-day duration was selected to arrive at a clear dose-response.)

- 14- and 20-day biomass tests were attempted using Ampelisca abdita, a tube-dwelling amphipod.

- A 28-day reproduction test was attempted with Ampelisca.

Neanthes arenaceodentata and Ampelisca abdita were chosen because they were the focus of substantial scientific research; neither are indigenous to waters of the Pacific Northwest. N. arenaceodentata is from California and has been used for regulatory decisions in a 10-day acute lethal bioassay but not in chronic bioassays with a sublethal endpoint. A. abdita has been used in the Puget Sound region; it is from the Atlantic Coast (Narrangansett Bay, Rhode Island) and San Francisco, California.

Test results indicated that Neanthes biomass increase showed best dose-responsiveness to sediments. For this reason, this test was considered the most promising of the potential tests.

This report was reviewed by the PSDDA EPWG and national biological testing experts. The report compares the Los Angeles karyotype of Neanthes in terms of biomass increase at the end of 20 days of growth in a test sediment to that in a reference sediment. Because biomass change is a sensitive parameter, a thoroughly documented testing method (protocol) was seen to be needed to set limits on factors (such as feeding rate and water quality) not related to sediment chemicals that could influence biomass increase during the test. A need was identified for further information on the variability of the organism response as it affects test precision within a single laboratory and between laboratories. Also, some reviewers felt that the ecological relevance of the test required further investigations.

A framework for test development (Hardy and Wakeman, 1988) was subsequently developed by the Corps and discussed by EPWG. On January 5, 1989, the framework was presented to EPA; and Neanthes was identified as a research priority. Ecology and EPA convened a national experts' workshop on February 28 and March 1, 1989 to discuss steps to be taken in test development and to identify research priorities in refining the Neanthes test. Experts agreed to a list of issues to be dealt with prior to establishing a protocol for further test development. At the present time, this protocol is being used for determining the growth response of the organism to a variety of factors. Concurrently, literature reviews on the use of biomass measures as estimators of chronic sublethal effects is being carried out. Results from these two research efforts should be available in fall 1989. At that time, the PSDDA agencies will review the results and determine whether further work is needed before the test can be considered for use in a regulatory context.

5.11 Clarifications of sediment holding times for chemical analyses and bioassays.

Chemical holding times. EPTA (1988) (page II-58) does not fully detail the holding times and conditions for sediments prior to chemical analyses given in the Recommended Protocols. What follows is a clarification to assist laboratories to avoid exceedance of chemical holding times. (It should be noted that programs such as Superfund may differ in statutory requirements from this specification.)

Particle size: sediments should be stored at 4°C for no more than 6 months.

Total solids, total volatile solids, total organic carbon, and ammonia nitrogen: sediments should be frozen at -20°C for no more than 6 months.

Total sulfides: sediments should be stored at 4°C for no more than 7 days.

Metals except mercury: sediments should be frozen at -20°C for no more than 6 months.

Mercury: sediments should be frozen at -20°C in tightly sealed glass (not plastic) containers for no more than 28 days. (Note that a special holding condition for mercury is used in the case of archived project sediments for assessing post-dredging sediment surface conditions described in section 5.7.)

Volatile organics: sediments should be stored at 4°C for no more than 14 days.

Semivolatile organics: sediments should be frozen at -20°C for no more than 1 year.

Biological holding times. EPTA (1988) (page II-58) recommends that biological testing begin not later than 6 weeks after collection, and that the samples be stored at 4°C under nitrogen gas. In contrast, the Recommended Protocols indicates a holding time for sediment (no atmosphere specified) in the dark at 4°C for a maximum of 2 weeks.

The PSEP Recommended Protocols were designed to maximize the quality and comparability of data generated within the Puget Sound region by various investigators. PSDDA procedures were selected for a tiered regulatory evaluation process. The PSDDA evaluation process takes into account data quality needs for making an environmentally protective regulatory decision, and requires biological testing only when there is a demonstrated reason to believe that sediments are potentially toxic. PSDDA thus enables dredgers to limit testing to the minimum required for project evaluation. However, this would not be possible under the Recommended Protocols specification for maximum biological holding time, since typical turnaround times for analysis of sediment chemicals is at least 3 to 4 weeks.

The PSDDA agencies will continue to consider new information to assure that the holding time recommendation does not result in false conclusions from biological testing. Some data indicate that toxicity may increase or decrease during holding. However, recent research conducted by the Corps' Waterways Experiment Station for the New York District, measuring the acute lethal response of the mysid, *Mysidopsis bahia*, as well as chemical bioaccumulation in the polychaete *Nereis virens*, examined the effects of sediment storage on sediment toxicity. Three test sediments and one reference sediment were evaluated at 0, 4, 8, 16, and 40 weeks after collection. Data for test sediments were compared to data for the reference sediment. The results indicated that the toxicity of the test sediments relative to the reference did not significantly change for sediments stored at 4°C for up to 16 weeks

(Henry Tatem, Corps' Waterways Experiment Station, personal communication, July 1989). Therefore, at this time there is good reason to believe that the PSDDA recommended maximum allowable sediment holding time of 6 weeks should not substantially affect the toxicity of properly stored sediments. Also, the PSDDA agencies are sponsoring further testing with the PSDDA suite of tests as well as the *Neanthes* 20-day biomass increase test that will further check the foregoing conclusion.

CHAPTER 6. DISPOSAL SITE MANAGEMENT

6.1 Introduction. This chapter discusses the disposal site use requirements, the permit process for gaining access to the disposal sites, permit compliance inspections, and agency roles in disposal site management. Environmental monitoring is discussed in chapter 7. For a typical non-Corps dredging project, the dredger (permit applicant) must apply for permits from the Corps and the State. State permits include Washington Department of Fisheries' Hydraulic Project Approval, Ecology's Water Quality Certification, and DNR Disposal Site Use Authorization (which incorporates the local shoreline requirements). For certain non-Corps Federal projects, not all of these State permits may be required. Permits, if granted, are conditioned to appropriate disposal site use requirements. Once permits have been granted the Corps, Ecology and DNR conduct inspections of dredging and disposal activities to ensure that those activities are in compliance with permit conditions.

In addition to describing management procedures for Phase II sites, this chapter contains updates to the Phase I Management Plans Technical Appendix (MPTA) (June, 1988). These updates relate to navigational controls for positioning (section 6.2.3), debris removal (6.2.7), and methods (section 6.4.1).

The following clarifies requirements for dredging permits. The dredger or permit applicant requesting Section 10/Section 404 permits is required to develop and provide four project-specific documents: a proposed sampling and analysis plan (the requirements for which are described in Exhibit A), a proposed dredging operations plan, and a proposed disposal operations plan. The proposed sampling and analysis plan specifies actions which will be taken to define and characterize dredged material management units. This plan will be reviewed and approved by the PSDDA agencies, who will later check the completion of the actions and compliance with the specified quality control measures. The latter two plans, which are described in the following paragraphs, specify the dredger's proposed operational controls for timing of dredging/disposal and debris handling. They will be reviewed and may be modified by the PSDDA agencies (Ecology and the Corps for the dredging plan, the Corps and DNR for the disposal plan), and will incorporate modifications specified as permit conditions. Navigation positioning plans will also be required and must be approved prior to the operation. Together, these plans will govern operations plans during dredging, transport, and disposal activities. Compliance inspections will confirm the adherence to the operating plans and permit conditions.

The proposed dredging operations plan will be submitted to Ecology and the Corps, and must describe: (a) final dredged material management units; (b) proposed positioning methods (see section 6.2.3, below) to meet the dredging positioning performance standards (plus/minus 2 m) and to assure that management units are treated as such; (c) debris identification, including operating definition of debris (see functional definition in 6.2 7), results of a predredging debris investigation, proposed handling of debris encountered during dredging, and (d) proposed timing for dredging (e.g., day, night, or 24 h). The predredging debris investigation could logically occur during the

sampling and analysis phase. A dredging/disposal journal is also required during operations, which records debris encountered, means of handling it, and fate (e.g., to a construction landfill).

The proposed disposal operations plan will be submitted to the Corps and DNR, and must describe: (a) debris handling at disposal site (see section 6.2.7, below and Exhibit C for details); and (b) the proposed timing for disposal. (DNR's site use authorization requires name of operator and name/number of disposal equipment, barge capacity, and disposal schedule.)

After approval of the permit, but before beginning the disposal operation, the permittee will provide a navigation positioning quality-control plan to the Corps and DNR for approval, which will specify the positioning method to be used.

6.2 Disposal Site Use Requirements. Unconfined, open-water disposal sites will be managed in accordance with the following general site use requirements which are discussed in more detail in the Phase I Management Plans Technical Appendix (MPTA) (June 1988). The management plan for each of the five Phase II disposal sites is presented in exhibit C to the Phase II MPR.

6.2.1 Target Area/Disposal Zone - Nondispersive Sites. In order to minimize the area of disposal site bottom impact, disposal operations have been given a surface target area with a 600-foot radius. Allowing for positioning error, this results in a 900-foot-radius surface disposal zone within which all dredged material must be released. See figure 4.2 for disposal site parameters.

6.2.2 Target Area/Disposal Zone - Dispersive Sites. At the dispersive sites, the target area and disposal zones are the same having a 1,500-foot radius.

6.2.3 Navigational Controls. Accurate positioning of disposal operations is critical to the success of the environmental monitoring program. Disposal site users should refer to navigation charts for navigation aids and terrain features available for positioning. A study of positioning methods and subsequent discussions with site users resulted in findings that some of the current positioning methods (visual sighting and standard radar) cannot reliably achieve accurate positioning. Used together, Loran-C and variable range radar should generally be capable of providing positioning with the desired level of accuracy at Anderson/Ketron Island and Bellingham Bay. However, the accuracy of positioning equipment may vary depending on the disposal site and how equipment is installed and operated. Therefore, disposal site users must specify a positioning method which demonstrates operational capability to position accurately with electronic or other approved methods. The navigation positioning plan will be reviewed and approved by the Corps and DNR prior to site use. Should field verification of the method selected demonstrate it is inadequate, alternate methods may be required. This also applies to all Phase I sites except Elliott Bay.

VTS coverage includes Port Angeles, Port Townsend, Rosario Straits sites in the Phase II area, and Elliott Bay in the Phase I area. At these sites, dredgers must contact the U.S. Coast Guard Vessel Traffic Service (VTS) to

verify their position in the disposal site during the disposal operations. The above positioning protocols may be revised in the future as experience is gained. Dredgers seeking use of PSDDA disposal sites should consult the Corps and/or DNR for current positioning requirements.

The PSDDA Phase I Section 6.2.2, Navigation Controls, is superseded by the above guidance.

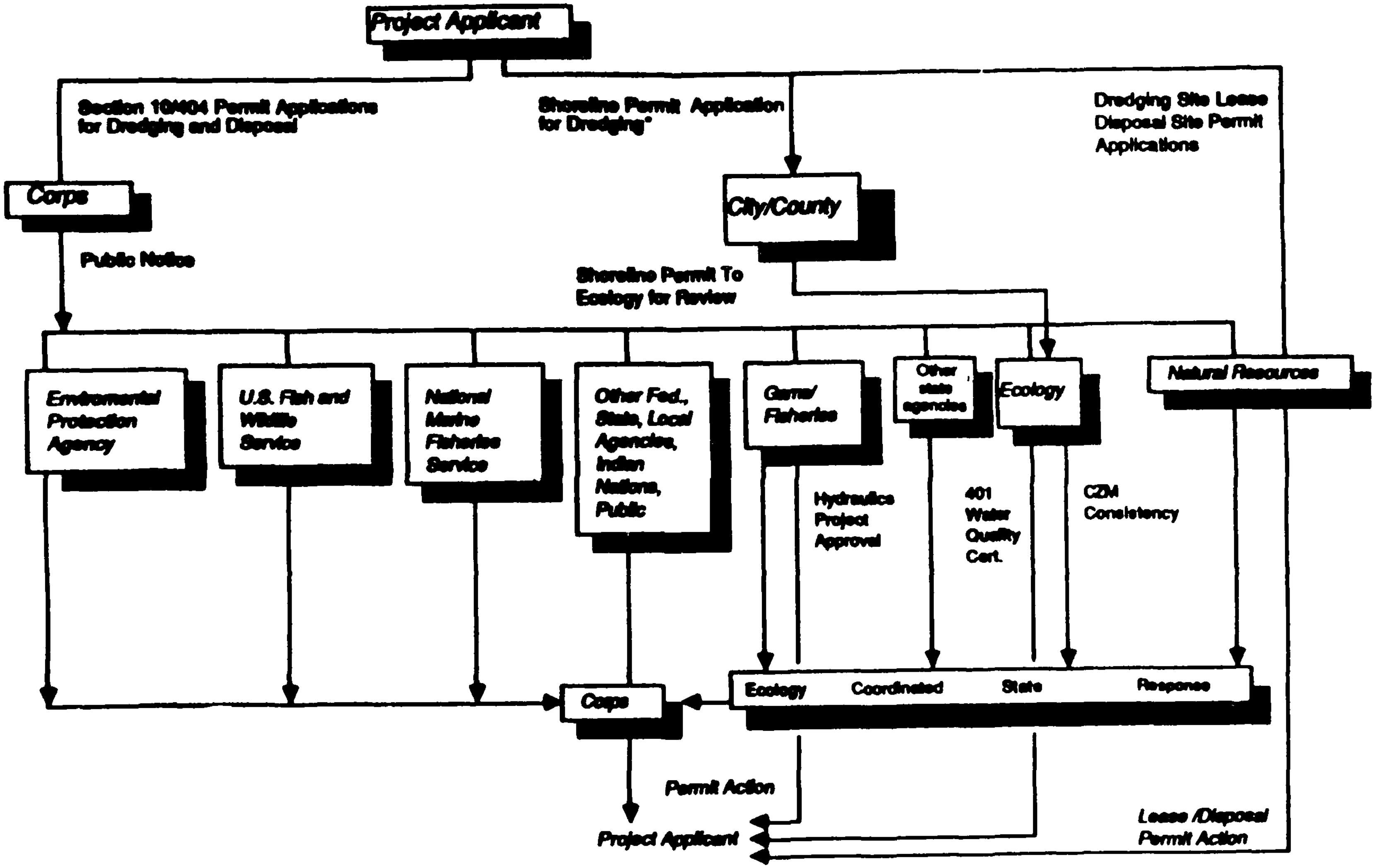
6.2.4 Noise Controls. Disposal operations will be required to meet the State noise standard (WAC 173-60).

6.2.5 Timing Restrictions. Dredging activity is generally prohibited by WDF regulations from March 15 through June 15 each year (general period of salmon and steelhead smelt out-migration). Dredging activities could also be limited or prohibited during other periods of the year in those areas where sensitive life stages of fish (other than salmon) or shellfish species occur such that dredging during these periods would have unacceptable adverse impacts. Timing concerns involve such commercially important species as Pacific herring (during spawning/egg laying stages) and Dungeness crab (during egg incubation and juvenile development periods). Other dredging projects in unique water quality areas may have timing restrictions if these areas are considered likely to experience seasonal reductions in water quality that could be exacerbated by dredging activities. However, these restrictions often increase dredging costs or impact dredging effectiveness. Such restrictions could impact certain projects by increasing costs to the point where dredging is no longer justified. Accordingly, dredgers are encouraged to seek definition of possible restrictions early in the process so that potential economic impacts are identified. While no other programmatic time restrictions apply to use of PSDDA disposal sites, concerns have been expressed by Indian tribes about potential conflicts between disposal site users and tribal fishing in those areas. Time restrictions and other conditions will be applied to individual projects as needed to prevent site-specific conflicts. However, these restrictions will be considered on a case-by-case basis and dealt with when applicants seek Section 10/404 permits. See FEIS section 2 for further discussion on this issue.

6.2.6 Bottom Dump Barges. In general, only bottom dump barges will be allowed to use PSDDA disposal sites in order to minimize water quality impacts. Other types of dumping, such as direct slucing or pushing material off flattop barges, result in greater dispersion of material.

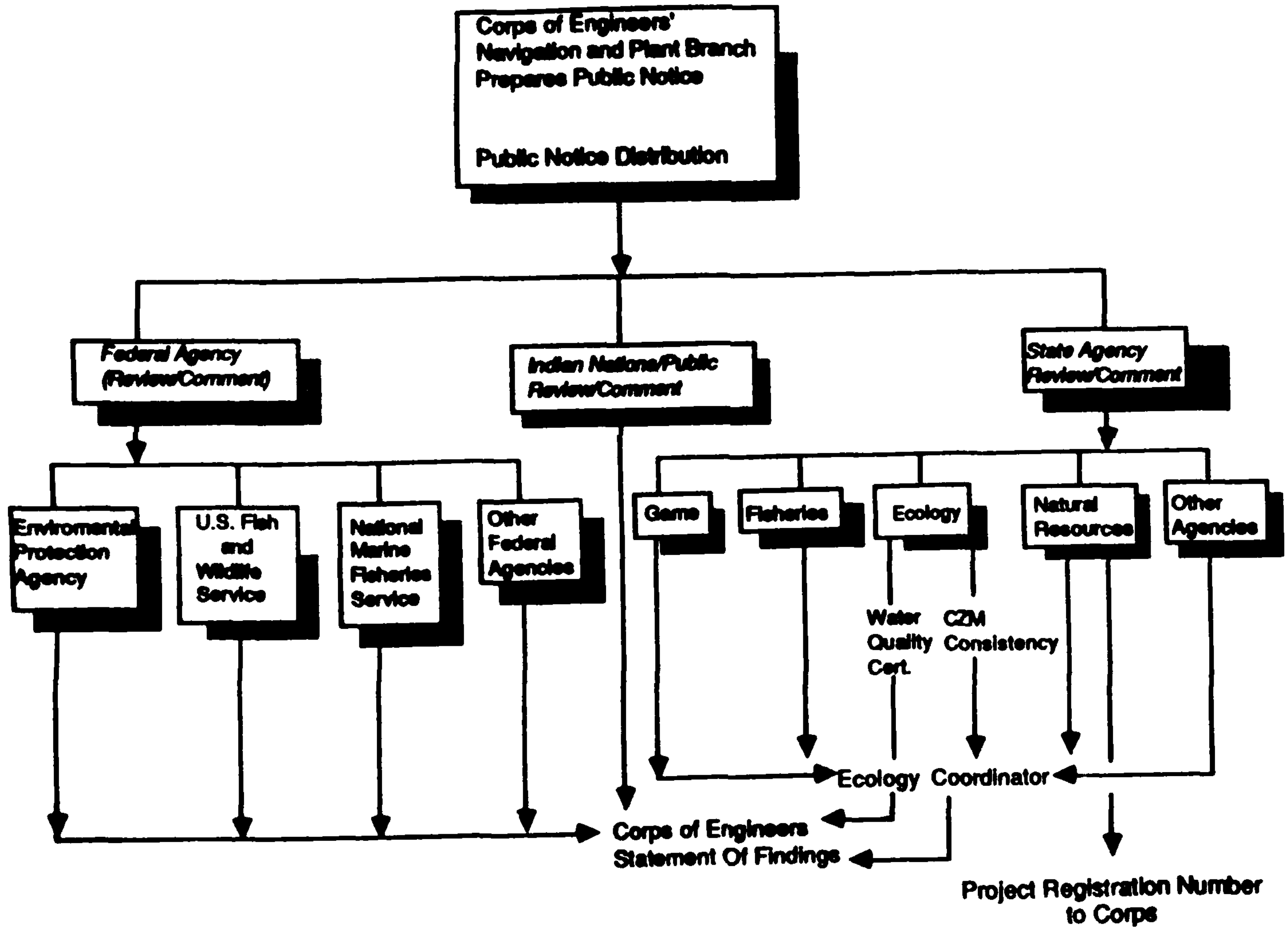
6.2.7 Debris and Floatables Removal. Debris is defined by the PSDDA agencies as material that could cause interference with particular uses. Floatable debris comprises material, such as logs, that could cause navigation hazards or solids, such as plastic or wood chunks, that could foul beaches. Nonfloatable debris comprises material that could reasonably be expected to cause conflicts with bottom-net or trawl fishing. Because functional definitions of debris are used, dredged material, if consolidated into large chunks, could itself be considered debris if, for example, it could snag nets and thus

Figure 6.1
Dredging and Disposal Permitting Process for
Non-Corps Projects



*DNR obtains permit covering all use of a disposal site.
No further shoreline permits are necessary for disposal.

Figure 6.2
Dredging and Disposal Permitting Process for Corps Projects



interfere with fishing activities. The contractor must include with the proposed dredging operations and disposal operations plans, the method (or methods) that will be used to remove debris or, if needed, to break large chunks of dredged material up, and this could include physically forcing material through a sieve or screen. A predredging investigation of site performed by the contractor and reported in his proposed dredging operations plan will disclose possible debris on the site, and may include actions described in paragraph 2.5 of exhibit C. Dredging site inspections will be made by the Corps and Ecology to ensure that the contractor is in compliance with the approved operating plans, and that identifiable nonfloatable debris are removed prior to discharge at unconfined open-water disposal sites. Floatable debris will be either removed at the dredging site or picked out of the water at the disposal site. The size of debris which must be removed will be specified in Corps 404 permits and contracts which address the debris that could be encountered during dredging. The dredging contractors are required to maintain a daily journal of activity, which shall include description of the handling of debris encountered during dredging and disposal. Compliance inspectors may review this journal.

6.2.8 Other Conditions. While not anticipated at this time, additional project or permit-specific requirements may be specified on a case-by-case basis and imposed as a specific condition for disposal of the individual Section 404 permit, Section 401 Water Quality Certification, or DNR site use permit.

6.3 Overall Permit Process. The overall permit process for dredging and unconfined, open-water disposal is shown in figures 6-1 and 6-2. Figure 6-1 shows the process for a non-Corps applicant seeking a permit to dredge and then dispose at an unconfined, open-water site. Figure 6-2 shows the process for Corps projects. Shoreline permits for disposal site use are obtained by DNR (see 6.3.1 and 6.3.5 below).

6.3.1 Local Shoreline Management Permits. Local governments have regulatory authority over use of unconfined, open-water disposal sites through the State of Washington Shoreline Management Act (SMA). The act establishes a locally based permit system guided by local shoreline management master programs and overseen by Ecology. The SMA, adopted in 1972 by the State of Washington, resulted in a State program for the management of the State's coastal resources with attention given to the environmental, economic, and social impact of resource utilization. Section 305 of the 1972 Federal Coastal Zone Management Act (CZMA) (Public Law 92-583) provides for the development of State management programs. The local shoreline master programs are part of the State of Washington Coastal Zone Management program, originally approved in 1976 by the U.S. Department of Commerce.

Pierce, Skagit, Whatcom and Clallam Bay counties will use their existing shoreline management master programs to evaluate DNR's applications for shoreline permits for the proposed Phase II sites. These applications will seek permits for the maximum possible period (currently 5 years).

After reviewing all the Puget Sound master programs, the PSDDA agencies concluded that there was a need for consistency among local jurisdictions in the treatment of dredging and dredged material disposal. Accordingly, suggested model shoreline master program policies and regulations for unconfined, open-water dredged material disposal were developed in cooperation with interested shoreline jurisdictions. The model language is contained in exhibit B to this report. The suggested master program policies and regulations have been related to the PSDDA management plans. A maximum permit period of at least 5 years is contained in the model policies and regulations which are recommended for adoption and use by each jurisdiction.

6.3.2 Section 10/404 Permit. Corps responsibility to regulate disposal of dredged or fill material in the waters of the United States is mandated by Section 404 of the CWA. The purpose of the CWA is to restore and maintain the chemical, physical, and biological integrity of waters of the United States. The Corps also regulates dredging under Section 10 of the River and Harbor Act. The review process for Section 404 and Section 10 permits is shown in figure 6-2.

EPA, in conjunction with the Corps, develops guidelines for the implementation and use of disposal sites under Section 404(b)(1). EPA is authorized by Section 404(c), to prohibit or restrict the use of a disposal site whenever it determines that the discharge will have "unacceptable adverse impacts." EPA also reviews and comments on Section 10/404 public notices issued by the Corps.

6.3.3 Section 401 Certification, Shoreline Management Act Oversight. Ecology has the responsibility for the State of Washington for certifying compliance with Section 401 of the CWA. This certification is required for any applicant of a Federal permit to conduct any activity which may result in any discharge into navigable waters lying within the State of Washington. The issuance of water quality certifications for non-Corps and Corps projects is shown in figures 6-1 and 6-2, respectively.

Ecology also establishes State-wide guidelines for State/local administration of the SMA. Ecology ensures that permits issued by local governments are consistent with the intent of the act. Ecology will encourage local governments to adopt the PSDDA model shoreline management master program policies and regulations. Permits issued by local governments for unconfined, open-water disposal will be reviewed by Ecology for conformance with State guidelines.

6.3.4 Hydraulics Project Approval. The Fisheries Code (RCW 75.20.100) and State regulations (WAC 220-100) establish the hydraulic project approval (HPA) process. The purpose of the HPA is to protect fish life. Through an interagency agreement with the Washington Department of Wildlife (WDW), WDF administers most HPA's in saltwater areas. The Corps Section 404 public notice, although not intended by the Corps, is accepted by WDF and WDW as the application for the HPA. The general permit process is shown in figure 6-1. Responsibility for ensuring compliance with the HPA lies with WDF.

6.3.5 Disposal Site Permit Activities of DNR. DNR is the proprietor of State-owned aquatic lands. In the past, DNR has used an established site selection procedure and issued open-water disposal permits. Sites were selected with the advice of an advisory committee, the Interagency Open-Water Disposal Site Evaluation Committee. This committee is composed of representatives of Federal and State resource agencies and meets when needed. See chapter 9 for a discussion of future agency coordination.

The DNR siting guidelines will be amended to be consistent with the PSDDA site selection process (see Phase I Disposal Site Selection Technical Appendix (DSSTA) June 1988).

DNR, concurrently with the public review of the Phase II draft documents, applied to Pierce, Skagit, Whatcom and Clallam counties for disposal site shoreline permits. DNR is the lead agency for compliance with the State of Washington Environmental Protection Act (SEPA) requirements associated with these permits. DNR will manage all sites and ensure compliance with site use requirements. The local shoreline jurisdictions will act on the DNR applications based on the final EIS for the Phase II study area.

DNR will continue to issue dredged material disposal permits for each individual, non-Corps disposal operation. The application process is shown in figure 6-1. These permits will be granted for the term of the project but generally no longer than 2 years. This evaluation will allow DNR to adjust site use to meet revised dredged material evaluation procedures or site use requirements as they are developed. For Corps projects having local sponsors (most projects), the project sponsor will be required by DNR to obtain a DNR permit.

6.4 Compliance Inspections. PSDDA disposal sites were selected and the evaluation procedures formulated in recognition of the needs of both environmental protection and waterborne commerce. Compliance with the PSDDA plan is required to ensure that both these needs are met. This will be accomplished through spot checking of dredging and disposal site activities.

6.4.1 Methods. The dredging operation will be inspected to ensure that only suitable material is taken to the unconfined, open-water disposal sites. Predredging sediment evaluation will determine the horizontal and vertical extent of materials which are suitable for unconfined open-water disposal. A visual inspection of the site will be made to assess the potential for debris. An inspection plan will be written for each dredging operation either by the Corps for Corps projects, or by Ecology for non-Corps projects. Details of what will be contained in the inspection plans are described in Phase I MPTA (June 1988). Inspections during dredging will be carried out by the Corps for both Corps and non-Corps projects; the latter to ensure compliance with Corps Section 404 permit conditions. Ecology will also conduct inspections of both Corps and non-Corps projects for compliance with their 401 Water Quality Certification. The Corps and Ecology will coordinate development of their respective inspection plans and inspections to avoid unnecessary duplication of effort. Copies of the inspection plans will be exchanged and provided to DNR.

Disposal barge positioning and other conditions of site use will be checked by both DNR and the Corps for Corps and non-Corps disposal activities. Compliance inspection at a particular disposal site will depend on the methods used for positioning at that site. At Phase I and II sites covered by VTS, VTS will be the primary means of checking barge positions. These site are Port Angeles, Port Townsend, and Rosario Strait in Phase II and Elliott Bay in Phase I.

Compliance inspection at other sites will be performed by radar from shore or other means adequate to verify the position and time of disposal. Depending on the verification methods selected, disposal site operators may be required to retro-fit barges with dump sensors, to provide and carry standard positioning transmitters, or to provide other evidence of positioning accuracy. Efforts will be made to minimize costs to disposal site users while meeting the need to positively verify barge positions. Operators should contact the Corps or DNR for current information on disposal site positioning monitoring requirements.

All non-Corps disposal site users will be required to submit records of site use to DNR. The Corps will provide copies of Corps contractor inspection reports to DNR. The Coast Guard will submit records to DNR of activity reported to VTS. These records will be used by the Corps and DNR in verifying compliance, and in the preparation of the annual PSDDA reports on disposal site use.

6.4.2 Violation Follow-Up. Violations of permits issued for dredging and use of unconfined, open-water disposal sites may involve the dredging operation, the presence of debris in dredged material taken to the disposal sites, positioning at the sites, or other special conditions of site use. Each agency has its own authorities for responding to violations (see Phase I MPTA). Any violations discovered by DNR, Ecology, or the Corps, through their inspection process, will be reported to the other agencies. Each agency will take appropriate action consistent with their own authorities and responsibilities. The agencies may elect to perform disposal site checks, or have the dredgers perform such checks, to confirm the absence of obstructing debris.

CHAPTER 7. DISPOSAL SITE ENVIRONMENTAL MONITORING

7.1 Need For And Objectives of Environmental Monitoring. The primary function of environmental monitoring is to ensure compliance with the Section 404(b)(1) Guidelines and to field verify the PSDDA predictions of site conditions following disposal. Moreover, monitoring will provide the data to allow direct response to agency and public questions regarding site conditions and environmental impacts.

This chapter presents the key features of the overall proposed PSDDA monitoring plan for the Phase II disposal sites. The Phase II sites include two nondispersive sites (Bellingham Bay in north Puget Sound and Anderson/Ketron Islands in south Puget Sound) as well as three dispersive sites (Rosario Straits, near Port Townsend and near Port Angeles, all in the north sound). The monitoring plan for nondispersive sites is designed to verify that no unacceptable adverse effects have occurred within or beyond the disposal site and to assure that dredged material disposed at the sites generally remains within the disposal site boundary. Dispersive sites will be periodically monitored to establish that there is no significant long-term mounding of dredged material resulting from disposal. Details of the environmental monitoring anticipated for the Phase II area are contained in exhibit D.

For the nondispersive disposal sites the monitoring plan is designed to address well-defined objectives or questions that directly relate to verification that unacceptable chemical and physical impacts have not resulted from dredged material disposal. These questions are:

- Does the deposited dredged material stay onsite?

- Is the biological effects condition for site management (Site Condition II) exceeded at the site due to disposal of dredged material?

- Are unacceptable adverse effects, due to dredged material disposal, occurring to biological resources offsite?

Under the disposal guidelines adopted for Phase I, and the Phase II nondispersive sites, "minor effects on biological resources," due to chemicals of concern, are allowed at the disposal site. This allows chronic sublethal biological effects onsite.

Due to the delay in initiating use of Phase I PDSSA sites and to new information on environmental monitoring costs, several changes are being made in Phase I monitoring also. These changes are made in the proposed schedule for environmental monitoring and are described in section 7.3.1.

7.2 Scope - Nondispersive Sites. Given the assumption that disposal will be limited to dredged material that is consistent with PSDDA disposal guidelines, environmental monitoring during actual disposal operations is not considered to be necessary. In addition to supporting biological information, this

decision is based on field studies that document a very small loss of fines and associated chemicals to the water column during disposal prior to impact on the bottom (see Phase I Evaluation Procedures Technical Appendix (EPTA) and Phase I Disposal Site Selection Technical Appendix (DSSTA) June 1988). Studies have also shown that conventional pollutants (e.g., sulfides, TOC, and total volatile solids) should not be a significant problem either. Consequently, water column and surface monitoring, as well as beach monitoring, will not be undertaken. Instead, the monitoring will focus on the benthic environment on or near the site. As the disposal sites are all located in low energy and low current areas, offsite impacts are not expected. However, offsite monitoring will be conducted to verify these expectations.

Significant numbers of mobile species are not anticipated at the active disposal sites. Onsite benthic communities are expected to be buried to varying degrees following disposal of dredged material. Full recolonization of the disposal sites is not expected during active use of the sites since continued disposal operations will tend to cover any recolonizers. Partial recolonization will occur each year during periods when dredging operations are restricted (due to fisheries closures), however, these recolonizers would be buried once disposal operations resume. Permanent recolonization of the sites is expected once the sites are no longer used for the disposal of dredged material (Dexter et al. 1984; Rhoads and Germano, 1986). Prior to that time, the sites are not expected to provide sufficient prey to attract additional mobile species beyond the few that were observed during site identification studies.

The environmental monitoring element of the Phase II management plan includes a predefined management response strategy for nondispersive disposal sites, dealing with how monitoring data are to be used and interpreted, i.e., "triggers" for appropriate management action. These actions may include additional sampling at the site ("verification sampling"), adjusting the evaluation procedures used to assess dredged material, or modifying use of the site.

Based on the questions set forth in paragraph 7.1, and utilizing accepted protocols, the monitoring plan specifies monitoring techniques, stations, and frequency for each of the Phase II nondispersive disposal sites. The key field analysis concepts used in the monitoring plan are: measurement of gradients, comparison to established guideline values, comparison to baseline conditions, and comparison to nearby benchmark areas. Gradient measurements assess parameters downcurrent from the site looking for evidence of offsite movement of dredged material of chemicals of concern from that material. Sediment chemical values and bioassay responses will be compared to the PSDDA guidelines to verify that acceptable conditions continue at the sites. This analysis will serve as a check of the sampling aspects of the disposal guidelines, i.e., characterization of the dredged material. Also, analysis of onsite dredged material will help provide a "field reason to believe," basis for deciding when additional site studies are necessary.

Comparison of offsite conditions to baseline conditions measured prior to disposal will be done to verify that no unacceptable changes have occurred due to

dredged material disposal. Changes in parameters onsite and offsite will be compared to nearby relatively undisturbed areas (benchmark stations) to determine if changes are due to other sources or natural fluctuations.

The most intensive monitoring will occur during the first few years of site use. This will allow for early response should unexpected adverse impacts occur. Future monitoring effort may be lessened if monitoring indicates no significant effects have occurred, (i.e., PSDDA evaluation procedures are producing the expected results). Field studies will be conducted during the same season each year (i.e., during late spring). Intensity of monitoring may differ from year to year depending on the volume of dredged material disposal during the year at the site. A tentative schedule of monitoring studies has been established for the sites, but this schedule may be adjusted if insufficient material is deposited at a site to warrant full study.

7.3 General Monitoring Plan - Nondispersive Sites. The general monitoring plan for the nondispersive sites consists of several types of field studies, each varying in intensity and frequency, and field measurement techniques. Illustrated in table 7.1, the various categories, parameters, and techniques, and their relation to the monitoring questions, are described in following paragraphs.

7.3.1 Monitoring Categories. The monitoring plan for the nondispersive sites will be accomplished in two separate steps: a baseline study before disposal takes place and periodic monitoring after disposal occurs. Due to delays in initiating disposal site use under Phase I, the currently anticipated environmental monitoring schedule for Phase I sites has been revised. Table 7.2 contains the currently anticipated schedule for baseline studies and environmental monitoring for all Phase I and II sites. The following paragraphs discuss environmental monitoring for both Phase I and II nondispersive sites.

a. Baseline. The purpose of the baseline is to document conditions existing at and around the disposal site and at benchmark stations prior to disposal of dredged material. The information will serve as a basis for comparison of postdisposal conditions at the site, allowing an assessment of disposal impacts. Baseline data have been obtained for the same chemical, bio- logical, and physical parameters that will be assessed during postdisposal monitoring.

Baseline studies of the non-dispersive sites were completed during the spring of 1989. While biological activities occur year round at the disposal sites, spring months are normally the time of high biological activity. This is when new recruitment occurs to the benthos and demersal predators experience higher feeding rates. Accordingly, the spring is the time in which most benthic impacts can be expected and, therefore, it serves as the best period for checking site conditions. Future monitoring will always occur during this same season to allow a comparison of data for trend analysis. The monitoring activity coincides with the normal dredging closure specified by the Washington Department of Fisheries to protect outmigrating salmon and steelhead smolts (March 15 to June 15).

b. Partial Monitoring. The purpose of partial monitoring is to verify that the dredged material is staying onsite and that acceptable conditions continue at the site. A minimum number of chemical stations will be sampled to determine chemical characteristics of the sediment. A map of the disposal area mound and spread will be produced by using sediment vertical profiling camera (SVPS) imagery. In addition, SVPS biological data will provide a general impression of biological impacts on and off site. Partial monitoring addresses two of the three key monitoring questions (see table 7.1).

c. Full Monitoring. The purpose of full monitoring is to determine if the physical, chemical, and biological parameters, documented during the baseline study, have changed. Full monitoring frequency will vary by site and disposal volume. However, full monitoring of a disposal site will be considered after 100,000 c.y. of dredged material have been placed there. Recent analysis suggests that measurable depths of material will not occur on the sites until at least 100,000 c.y. has been placed at the sites. Verification of the appropriate trigger volume will occur during monitoring of high volume disposal sites in the Phase I area.

Currently, two full monitoring studies are believed to be necessary within the first 5 years of site use (depending on volume placed at each site) to establish whether unacceptable impacts are occurring on or off site. Full monitoring addresses all the questions discussed in paragraph 7.1 (also see table 7.1). As the PSDDA agencies gain information from the initial monitoring efforts and from developments in the science, monitoring needs will be reappraised. A current monitoring schedule projection will be maintained by DNR and be available to the public on request.

7.3.2 Monitoring Parameters - Nondispersive Sites. Three general groups of parameters will be measured during baseline and monitoring: physical, chemical, and biological. They employ different sampling tools and stations.

a. Physical. The purpose of physical measurements is to discern the areal extent of the disposal impact area. This will be accomplished through stratagic placement of SVPS stations.

b. Chemical. Chemical monitoring stations will be sited based upon the results of the physical measurements. The purpose of chemical measurements is to document the presence of chemicals of concern on and off site due to dredged material disposal and establish if they are causing unacceptable adverse impacts. This serves as a check on the sampling and analysis of the dredging site sediments and helps to answer the questions: (a) was the dredged material properly characterized and (b) has the site management condition been met? Bioassays will be conducted at some of these stations.

TABLE 7.1

RELATIONSHIP OF KEY MONITORING QUESTIONS TO TYPES OF MONITORING, PARAMETERS, AND TECHNIQUES USED IN THE PHASE I AND PHASE II ENVIRONMENTAL MONITORING PLAN FOR NONDISPERSIVE DISPOSAL SITES

Monitoring Questions

	Material Stays Onsite?	Site Management Condition Not Exceeded?	Biological Resources - Unaffected Offsite?
Types of Monitoring:			
Baseline	X	X	X
Partial Monitoring	X	X	
Full Monitoring	X	X	X
Parameter:			
Physical Mapping	X		
Sediment Chemistry-Onsite		X	
-Offsite	X		
Sediment Bioassay-Onsite		X	
Infaunal Tissue Chemistry			X
Infaunal Abundance			X
Techniques:			
Box Cores		X	X
SVPS 1/	X		

1/Sediment vertical profiling system.

TABLE 7.2

ANTICIPATED SCHEDULE FOR BASELINE STUDIES AND ENVIRONMENTAL MONITORING AT EACH DISPOSAL SITE OVER A 15-YEAR MONITORING PERIOD[1]/

FISCAL YEAR	PHASE II Bellingham Bay	PHASE II Anderson/ Ketron Is	PHASE II Dispersive Sites	PHASE I Port Gardner	PHASE I Elliott Bay	PHASE I Commencement Bay
1988				B	B	B
1989	B	B	B			
1990					F	F
1991	F			F		
1992						
1993				F	F	F
1994			Ph			
1995	P				P	
1996						
1997		F				
1998				P		P
1999	F		Ph		P	
2000						
2001						
2002						
2003						
2004	P	P	Ph	P	P	P

B = Baseline
F = Full Monitoring
P = Partial Monitoring
Ph = Physical Monitoring

1/ Monitoring efforts will only take place after the sites have been used and volumes are sufficient to reasonably expect that observable changes will be present. Dispersive sites (Port Angeles, Port Townsend, and Rosario Strait will receive physical monitoring only. This table also shows revised monitoring schedules for Phase I sites based on updated volumes anticipated.

c. Biological. The purpose of biological measurements is to augment chemical measurements by documenting benthic organism responses to the presence of chemicals in their environment. For the disposal site, bioassays will be used to check the site management condition. Biological tests of offsite stations will measure biological responses through bioaccumulation tests and a check of benthic infauna abundances. These responses will be compared to baseline and/or along a gradient to determine if there is an unacceptable impact from dredged material disposal.

Measurements will be made on the bioaccumulation of toxic chemicals in the body tissue of sessile benthic organisms such as worms and clams that have been taken from the gradient and bench mark offsite stations. Bioaccumulation examines the relative exposure of these organisms to chemicals in the sediments, overlying water, and suspended particulate matter (nepheloid layer), and the relative uptake of those chemicals. Chemical levels in tissues of benthic species have implications for the health of the measured organism, and for the degree to which the contaminant levels may affect tissue residues of predators.

d. Offsite Benchmark Stations. The purpose of offsite benchmark stations is to determine if differences in chemical and biological measurements, noted during monitoring of the disposal site, represent natural or background variation at a similar depth and substrate within the general area. In general, samples from these stations will be archived, and analyzed only if sufficient changes occur at the other monitoring stations to warrant a check of the offsite benchmark station data.

7.4 Data Analysis, Interpretation, and Response - Nondispersive Sites.

7.4.1 Introduction. Management of the nondispersive disposal sites will be based upon analysis and interpretation of the field monitoring data, and upon subsequent agency administrative decisions. Monitoring data will be analyzed either through an evaluation based on the PSDDA dredged material disposal guidelines or a statistical comparison of the monitoring data to baseline data. Interpretation of the monitoring results, in terms of ecological significance, will require an understanding of the data evaluation procedures, and professional judgment. In addition to data analysis and interpretation, site management actions will depend on the degree of environmental risk and other considerations, e.g., feasibility.

Statistics will only be employed in the data analysis phase, solely to identify where observed differences between monitoring data (obtained subsequent to use of the site for dredged material disposal) and baseline data (obtained prior to site use) are potentially significant when considering the methods used, the variability of the parameters measures, the number of measurements made on each parameter, and the magnitude of the observed differences. Statistics consider the accuracy and precision of the monitoring methods in indicating whether the observed differences at the disposal site warrant further professional evaluation. Statistical significance does not imply ecological significance; professional judgment is essential in interpreting monitoring indications and recommending site management actions.

Statistical indicators used in data analysis are often developed by application of statistical power analysis, a widely applied environmental planning tool for considering the relationship between parameter variability, the number of samples to be taken, and the statistical confidence desired in the resulting data. The statistical triggers used in the monitoring plan are determined primarily by the variability of the parameter being measured and the work effort (number of samples) allocated by the monitoring plan. They represent minimum differences that should be observed before additional data interpretation (to consider ecological significance) is conducted.

Several study participants suggested using differences between monitoring and baseline data that were substantially smaller than those shown in the monitoring plan for determining if a condition of concern exists. However, the power analysis indicated that these smaller differences would not be possible to measure without substantially more samples and analysis or significantly reducing the desired confidence level (see Phase I MPTA, June 1988). Consequently, the study participants agreed that the statistically derived differences were the best possible, given the current level of monitoring effort proposed.

7.4.2 Data Analysis. Onsite monitoring on the nondispersive sites will be limited to verification that the site management condition has not been exceeded. This will be done through analysis of onsite sediment chemical concentrations and bioassays. If the site management condition is being exceeded, then disposal guideline adjustments will be considered.

Analysis of the monitoring data for offsite checking and development of a management response to the findings is a more complex process that includes both statistical procedures and professional review of the data. Each step in the three-step process can be posed as a question that must be addressed before moving to the next step in the decision making process. The answer to each question determines whether further evaluation of the monitoring data is required. The question associated with each of the decision making steps is:

Step 1: Are the values for the parameters measured during monitoring different from the values found during the baseline?

Step 2: If differences (or exceedances) are found, are they due to the disposal of dredged material or due to other causes (changes due to other chemical sources or due to natural variation)?

Step 3: If the differences (or exceedances) are due to the disposal of dredged material, what type of management action is warranted based on an assessment of the ecological impact associated with the changed conditions?

The first step in the process would be to determine whether the values observed during the monitoring effort (partial or full monitoring) differ from the values found during the baseline (step 1 in the site management process). Depending on the parameter being evaluated, one of several methods would be used to determine if the monitoring data are different from the baseline

values. Sediment chemistry and SVPS data used to determine if the dredged material has spread beyond the disposal site would be compared to data on sediment characteristics gathered during the baseline for stations at the site perimeter line located approximately 1/8 of a mile beyond the site boundary.

Offsite chemical concentrations and bioassay results at other stations would be compared to baseline values for sediment chemical concentrations and toxicity (bioassays). Data on benthic body burdens and benthic abundance would be statistically compared to the baseline data to determine if differences between the data are supported. The interpretation guidelines for all of these comparisons is presented in the Phase I MPTA, exhibit I, June 1988.

If comparison of the monitoring data to the baseline data does not indicate that any offsite changes have occurred since disposal activity began, then it can be reasonably assumed that dredged material discharged at the disposal sites is staying onsite. However, if any of the data are found to differ from the baseline values then a question arises as to whether the differences observed are due to dredged material disposal or due to other factors affecting the disposal site area (step 2 in the site management process). Exhibit I of Phase I MPTA (June 1988) describes how this question will be addressed.

7.4.3 Response. If the changes observed in the vicinity of the disposal site are concluded not to be due to disposal of dredged material, then no management action would be required. If, however, analyses of the data suggests that changes around the disposal site may be due to dredged material disposal, then best professional judgment would be applied in evaluating the ecological significance of the observed changes (step 3 in the site management process). The variety of management actions that might be appropriate at this time could include (in order of increasing significance):

- analysis of the remaining archived samples for the other monitoring parameters to determine the extent and the ecological significance of the changes;

- offsite investigations to verify the presence of dredged material and to determine the extent and ecological significance of the effects;

- program adjustments, such as modification of site use or amendment of disposal guidelines to bring the site management into CWA requirements of not allowing unacceptable adverse impacts; and

- major program responses such as site relocation or mitigation at the existing site.

Any action, however, must be based on a careful evaluation by all the PSDDA agencies of the monitoring results and an interpretation of these findings relative to potential ecological significance.

7.5 Application of Dilution (Mixing) Zones - Nondispersive Sites. The State Water Pollution Control Act (RCW 90.48) enunciates the policies, authorities,

scope, and enforcement programs to protect waters of the State. Provisions of the act allow for promulgation of rules and regulations relating to standards of water quality and for substances discharged therein, including sediments.

The State water quality standards (WAC 173-201) provide for dilution (mixing) zones when the standards cannot be met. For purposes of compliance with the State water quality standards, the dilution zone of each PSDDA disposal site will include the site itself and the adjacent area out to the perimeter line used in environmental monitoring. The State water quality certification (Section 401) and/or modifications (WAC 173-201-035), for each project granted a permit for disposal at PSDDA site, will contain standard language describing the dilution zone.

7.6 Identification of Concerns That Warrant Monitoring - Dispersive Sites. Dispersive sites are located in areas of high bottom currents where dredged material placed at the site is expected to be rapidly transferred offsite. This precludes practical monitoring for chemically caused biological effects. Accordingly, a more restrictive disposal guideline has been proposed for the dispersive sites. However, each dispersive site will be monitored, using precision vertical soundings, to determine if long-term mounding of dredged material is occuring which could impact commercial trawling that might occur at these sites.

During baseline, vertical soundings over continuous transects were made at the site at 100-meter spacing. The transects began and ended 100 meters outside the disposal site. The information will be maintained at the Corps of Engineers. During monitoring, the same transects will be rerun using the same type or quality of equipment as used in baseline. The Corps of Engineers will compare the baseline profiles to the monitoring profiles to determine if a significant change has occurred. See exhibit D for details on the monitoring of dispersive sites.

7.7 Agency Responsibilities, Costs, and Funding. Environmental monitoring baseline of the nondispersive disposal sites was established by Ecology with $223,000 appropriated from the State general fund for this purpose. The Corps has accomplished baseline studies of the dispersive sites at a cost of $25,000. The Corps and DNR will be jointly responsible for subsequent environmental monitoring. Monitoring studies will be coordinated to minimize costs, assure proper temporal sequencing, and data compatibility. Environmental monitoring reports produced by the Corps and DNR will be exchanged and provided to EPA and Ecology for technical review. From these reports, Ecology will prepare a summary report that will be the basis for the periodic review by the PSDDA agencies, affected local governments, and other interested parties of disposal site monitoring (see chapter 9).

The Corps will generally be responsible for the costs of physical monitoring of both dispersive and nondispersive disposal sites, currently estimated at $186,900 (inclusive of baseline monitoring) for the 15-year period. DNR will generally be responsible for conducting chemical and biological monitoring, the cost of which is currently estimated at $527,000 for the 15-year period. Funding of environmental monitoring is discussed in chapter 9. Baseline studies and subsequent monitoring will be accomplished within available funds.

CHAPTER 8. DREDGED MATERIAL DATA MANAGEMENT

8.1 Introduction. This chapter describes how data, collected in implementing the PSDDA Phase I and II management plans, will be managed through an overall data management system. Data on sediment quality are currently collected and stored through a variety of mediums from elaborate computer systems to simple paper files. Several major studies have utilized microcomputer systems, while sediment data from everyday processing of dredging project permit applications have been assembled in paper files.

The PSDDA study has generated considerable data in developing sediment evaluation procedures and the extensive gathering of biological and physical data on preferred and alternative disposal sites. Implementation of the PSDDA plans is producing much more data and a requirement for immediate data analysis. This further supports the need for an overall dredged material data management system. It is the intention of the PSDDA agencies that data be collected and stored in a format that is useful to as many users as possible, with the data easily accessible to all interested parties.

Annual reviews are being conducted by the PSDDA agencies and other interested parties of all elements of the management plans based on the environmental monitoring data collected for each of the selected public multiuser unconfined, open-water disposal sites, and the data generated from implementation of the dredged material evaluation procedures. Consideration is being given to costs and environmental effects associated with the plans as well as new findings resulting from nationwide and Puget Sound research. The intent is to ensure appropriate management adjustments are made on a timely basis, consistent with adequate supporting information and sound scientific considerations (see chapter 9 for further discussion of the annual review and update of the PSDDA plans).

8.2 Data Management Objectives. Some of the data resulting from the PSDDA program will be immediately analyzed with the results used in administrative decisions. This includes sediment test results and environmental monitoring. Other data, such as disposal site use logs, will be stored for documentation or later long-term evaluations. The objectives of data management are to: (a) facilitate the PSDDA management plans and (b) provide the means for anuual review and update of the plans.

As regulatory agencies and project sponsors are interested in the costs associated with dredged material evaluations, permit applicants are being asked to also provide information on sampling and testing costs incurred. This cost data will become part of the overall data management program and be readily considered during annual program reviews.

8.3 Dredged Material Test Data. Dredged material sediment test data, obtained by the Corps for Section 10 and 404 permit applications and by Ecology for Section 401 water quality certifications, is being maintained by the Corps on a computer system developed subsequent to completion of Phase I. Cost data on

sampling and testing is also being collected and maintained on the system. The Corps will prepare an annual report summarizing data for dredged material tested over the previous dredging year (which ends on March 15). Sediment quality data from environmental monitoring of the disposal sites will also be maintained on the Corps computer system. See paragraph 8.6 for related sediment quality data management activities by Ecology.

8.4 Dredging and Disposal Permit Compliance Data. Dredging site inspection plans and permit and water quality certification compliance findings collected by Ecology and the Corps during dredging site inspections are being sent to DNR as they are developed. DNR is storing these data in a hard copy file along with disposal site use permit compliance findings obtained by DNR and the Corps. Compliance findings and operational status are being stored by DNR on a personal computer for active projects. DNR will provide an annual permit compliance report to the relevant local jurisdictions, other PSDDA agencies, and other interested parties.

8.5 Environmental Monitoring. DNR and the Corps share environmental monitoring responsibilities in recognition of each agency's defined regulatory responsibilities and requirements. DNR is generally responsible for biological and chemical monitoring, and providing that data to the Corps for input to the PSDDA data management system. The Corps is generally responsible for physical monitoring, including the collection and analysis of physical data and inputing these data to the PSDDA system.

The environmental monitoring data is being maintained in a computerized system which allows statistical manipulation of the data for trend analysis. Technical reports will be prepared by the Corps and DNR for their respective monitoring activities, for each disposal site, within 2 months after field data have been collected and laboratory work completed. These reports will summarize the field data, analyze the significance of the data in relation to the monitoring objectives and draw tentative conclusions as to whether or not the data suggest a basis for concern based on ecological significance. Copies of the reports will be provided for technical review to the other PSDDA agencies. Ecology will prepare an environmental monitoring summary report based on the Corps and DNR technical reports. The summary report will be part of the annual review of the PSDDA plan with copies of this report made available to the PSDDA agencies and other interested parties, e.g., Puget Sound Indian tribes, ports, local shoreline jurisdictions, etc. (see chapter 9).

8.6 Data Management System. The Corps is responsible for developing and maintaining the computerized information management system for the data described in paragraphs 8.3 and 8.5 above. The other PSDDA agencies have access to this system. To ensure greatest possible utility, the system has been planned on a cooperative basis through a PSDDA agency representative data management working group. Interagency agreement has been documented in an exchange of letters among the PSDDA agencies which set forth: (a) the scope of the system, (b) quality assurance (QA) requirements for data entered into the system, (c) data input and output formats, (d) responsibilities for data analysis, (e) system accessibility, (f) agency responsibilities, and (g) other appropriate aspects of concern to the PSDDA agencies.

The Corps PSDDA database system is real time, accessible to the other PSDDA agencies, in a format compatible with Ecology's data management system and, to the extent feasible, also compatible with the Puget Sound Water Quality Authority's (PSWQA) system. The Corps will perform a QA check of all sediment test data resulting from project evaluations prior to entering these data into the PSDDA data management system. Stored PSDDA sediment test data will be provided to Ecology for updating sediment quality values used to compute the Apparent Effects Threshold (AET) values which are employed in setting the screening level (SL) and maximum level (ML) values for the PSDDA evaluation procedures (see chapter 5 and exhibit A, and the Phase I Evaluation Procedures Technical Appendix (EPTA) section II). Ecology may also use other Puget Sound sediment data that meets QA checks for updating the AET values, including that resulting from the Puget Sound Ambient Monitoring Program (PSAMP) and other programs. As part of this update, Ecology will assess the need for changes in the sediment quality values used in the PSDDA evaluation procedures and present this assessment along with supporting data and analysis to the other PSDDA agencies as part of the annual review of the PSDDA plans.

CHAPTER 9. PSDDA IMPLEMENTATION

9.1 General Requirements. Individual and cooperative actions will be required by the Corps, EPA, DNR, Ecology, local governments, and others to implement the PSDDA managment plan for the Phase II area as is being done for the Phase I area. Many aspects of these plans relate to individual actions under Sections 404 and 401 of the Clean Water Act. Some aspects, particularly dredged material testing, test interpretation, and determination of acceptability for unconfined, open-water disposal, are highly technical and complex and, therefore, require considerable expertise for proper evaluation. Accordingly, technical expertise, required for project analysis, will be contributed by each of the regulatory agencies and the annual reviews of the dredged material evaluation procedures will be a cooperative undertaking by all four PSDDA agencies.

Close coordination will also be necessary to implement the PSDDA plan for the Phase II area as has been the case for the Phase I area. New scientific information is continually being developed on Puget Sound water and sediment quality, on the toxicity of various chemicals of concern, and on appropriate testing protocols. These facts, along with the recognition that agency personnel changes will occur, require established communications procedures. Dredged material management activities needing interagency coordination include the following:

- Review and processing of permit applications for dredging and dredged material disposal.
- Application of dredged material evaluation procedures to determine testing and test interpretation for specific projects.
- Consideration of adjustments in dredged material evaluation procedures.
- Use of public multiuser unconfined, open-water disposal sites.
- Environmental monitoring and consideration of adjustments to disposal site environmental monitoring.
- Consideration of new disposal sites and/or changes in existing site locations or boundaries.

9.2 Roles and Responsibilities. The various roles and responsibilities of each of the four PSDDA agencies, for implementation of the Phase II management plan, are discussed in the following paragraphs. These paragraphs also apply to the Phase I area as they reflect the current intent of the PSDDA agencies. Implementation is predicated, where appropriate, on the availability of required funds.

9.2.1 Corps of Engineers. The Corps will:

a. Consider, in conjunction with EPA, PSDDA sediment evaluation procedures, including disposal guidelines, in specifying dredged material sampling and testing requirements for Section 404 permits.

b. Cooperate with EPA and Ecology when processing applications for Section 404 permits.

c. Provide Section 404(b)(1) dredged material evaluation reports on Corps dredging projects to Ecology and EPA prior to making disposal decisions.

d. Develop a dredging and disposal operation inspection plan (see June 1988, Management Plans Technical Appendix (MPTA)), for each Corps dredging and disposal project and provide a copy to Ecology and DNR prior to initiation of dredging.

e. Comply with all appropriate disposal site use requirements (see chapter 6) when the disposal site is being used for Corps dredging projects.

f. Inspect each Corps and Corps permitted dredging and disposal project in a similar manner as Ecology and DNR inspect non-Corps dredging and disposal projects (see MPTA).

g. Advise Ecology and DNR of any violations to the Section 404 permit by Corps and Corps permitted dredging contractors. Also advise Ecology and DNR of any actions the Corps regards as being required because of the violation(s).

h. Provide to DNR the disposal site use reports on Corps and Corps-permitted dredging projects.

i. Prepare by September of each year the annual summary report on dredged material sampling and testing conducted, and for which quality assurance has been passed, by June 15 of that year for Section 10 and 404 dredging and dredged material disposal project actions (permits and Corps projects (existing, and proposed that are under study)) and Section 401 water quality certifications. Reports will include data on the costs of sampling and testing. Information will be provided for each public multiuser unconfined, open-water disposal site.

j. Conduct physical environmental monitoring studies of the disposal sites and coordinate these with DNR biological and chemical environmental monitoring studies. Input the physical monitoring data to the Corps data management system. Prepare within 2 months of the completion of the monitoring studies a technical report on physical monitoring for each disposal site for that monitoring event. Relate the new monitoring data to data from previous monitoring events. Provide these reports to EPA, DNR, and Ecology for technical review. Review environmental monitoring and disposal site use reports prepared by DNR and Ecology. As part of the annual PSDDA plan review and update (see m. below) present Corps proposed disposal site management changes.

k. In conjunction with EPA, DNR, and Ecology, review the sediment quality values and biological tests used in the PSDDA dredged material evaluation procedures, and assess the need for changes in these procedures based on environmental monitoring data, other pertinent environmental information, e.g., Ecology's expanded sediment quality data management system, new research findings, etc., and cost considerations (including dredging and dredged material disposal in addition to sampling and testing). As part of the annual PSDDA plan review and update present Corps proposed changes to the evaluation procedures.

l. Develop and maintain a centralized computer data based system for all pertinent Section 10, 404, and 401 dredged material sediment quality data and physical, chemical, and biological baseline and environmental monitoring data collected for each public multiuser unconfined, open-water disposal site. Make the data and the computer system accessible to EPA, DNR, and Ecology. The data will also be made available to others subject to request processing requirements.

m. Convene in February of each year the annual PSDDA plan review and update meeting, prepare the meeting record, and distribute by May the notification to interested parties of agreed upon changes to the plan. The Corps will implement those plan changes, if any, that are in agreement with applicable Corps policies and within its authorities, responsibilities, and funding capabilities.

9.2.2 Environmental Protection Agency. EPA will:

a. Consider, in conjunction with the Corps, PSDDA sediment evaluation procedures, including disposal guidelines, in specifying dredged material sampling and testing requirements for Section 404 permits.

b. Review the annual summary report prepared by the Corps on dredged material sampling and testing for Section 10 and 404 permits and Section 401 water quality certifications.

c. Review Section 404(b)(1) dredged material evaluations for Corps projects in cooperation with the Corps and Ecology.

d. Review Corps, DNR, and Ecology environmental monitoring and site use reports.

e. In conjunction with the Corps, DNR, and Ecology, review the sediment quality values and biological tests used in the PSDDA dredged material evaluation procedures based on the considerations identified in paragraph 9.2.1.k. above. As part of the annual PSDDA plan review and update (see f. below) present EPA proposed changes to the evaluation procedures.

f. Participate in the annual PSDDA plan review and update meetings. Implement those agreed upon plan changes, if any, that are in agreement with applicable EPA policies and are within its authorities, responsibilities, and funding capabilities.

9.2.3 Department of Natural Resources. DNR will:

a. Amend WAC 332-30-166 to be consistent with the disposal site selection and management process developed through PSDDA, including revising the fee schedule and interagency coordinating committee.

b. Notify existing disposal site permittees that their existing DNR permits will have to be amended prior to use of the preferred disposal sites.

c. Acquire local shoreline management permits for preferred unconfined, open-water disposal sites for the maximum period permissible (currently 5 years).

d. Perform disposal site user permit (DNR) compliance inspections.

e. Enter into formal agreement with the U.S. Coast Guard for continued use of the VTS (Vessel Traffic System) for verifying proper disposal barge positioning at the Port Angeles, Port Townsend and Rosario Strait preferred disposal sites.

f. Establish Loran-C coordinates for use by disposal barge operators at all Phase II disposal sites.

g. Continue use of the current DNR data management system for tracking disposal site use and share this information with all interested parties.

h. Review the annual summary report prepared by the Corps on dredged material sampling and testing conducted for Section 10 and 404 permits and Section 401 water quality certifications.

i. Conduct chemical and biological environmental monitoring studies of the public multiuser unconfined, open-water disposal sites and provide these data to the Corps for input to the Corps data management system. Prepare within 2 months of the completion of the monitoring studies a technical report for each disposal site for that monitoring event. Relate the new monitoring data to data from the baseline and/or previous monitoring events. As part of the annual PSDDA plan review and update (see 1. below) present DNR proposed disposal site management plan changes.

j. Prepare annual site use reports and provide to PSDDA agencies, local shoreline jurisdictions, and others.

k. In conjunction with the Corps, EPA, and Ecology, review the sediment quality values and biological tests used in the PSDDA dredged material evaluation procedures based on the considerations identified in paragraph 9.2.1.k above. As part of the annual PSDDA plan review and update present DNR proposed changes to the evaluation procedures.

l. Participate in the annual PSDDA plan review and update meetings. Implement those agreed upon plan changes, if any, that are in agreement with applicable DNR policies and within its authorities, responsibilities, and funding capabilities.

9.2.4 Department of Ecology. Ecology will:

a. Adopt, through regulation or as agency guidelines, PSDDA dredged material evaluation procedures as a basis for Section 401 water quality certification determinations.

b. Conduct baseline studies at each disposal site in conformance with the PSDDA monitoring plan and transmit data to Corps for entry into Corps dredged material data management system. Provide these data to DNR for comparison with results from subsequent environmental monitoring studies.

c. Develop dredging operation inspection plans for non-Corps projects and coordinate with the Corps to assure inspection plans are similar to those for Corps projects.

d. Conduct onsite inspections of Corps (per the Corps developed inspection plans) and non-Corps dredging projects and report results to the Corps.

e. In conjunction with the Corps, EPA, and DNR, review the sediment quality values and biological tests used in the PSDDA dredged material evaluation procedures and assess the need for changes in these procedures based on the considerations identified in paragraph 9.2.1.k above. As part of the annual PSDDA plan review and update (see i. below) present Ecology proposed changes to the evaluation procedures.

f. Review DNR and Corps disposal site use and environmental monitoring technical reports.

g. Prepare within 2 months of receiving the Corps and DNR technical monitoring reports a summary report on the physical, chemical, and biological environmental monitoring studies which assesses the effectiveness of the environmental monitoring plan and the need for changes in management of the public multiuser unconfined, open-water disposal sites in accordance with the procedures contained in exhibit D to the MPR. Provide this report, at least 1 month prior to the annual plan review meeting, to the Corps, EPA, DNR, and other interested parties, e.g., local shoreline jurisdictions, Indian tribes, ports, etc. As part of the annual PSDDA plan review and update present Ecology proposed disposal site management changes.

h. Assess need for changes in dredged material evaluation procedures based on Corps evaluation procedures and monitoring reports, on DNR monitoring and disposal site use reports, Ecology environmental monitoring summary report, and other relevant regional and national sources, e.g., PSEP, PSWQA, WES research, etc. Propose appropriate changes to evaluation procedures which may

be more or less restrictive than procedures in effect at the time of the annual review. Present analysis and proposed changes in a management plan assessment report at least 1 month before annual review meeting.

i. Participate in the annual PSDDA plan review and update meetings. Implement those agreed upon plan changes, if any, that are in agreement with applicable Ecology policies and within its authorities, responsibilities, and funding capabilities.

j. Assist local governments in amending their shoreline management master programs to be consistent with PSDDA-recommended model shoreline master program elements for unconfined, open-water dredged material disposal (see exhibit B).

9.2.5 Local Shoreline Jurisdictions. Clallam, Whatcom, Skagit and Pierce Counties are asked to:

a. Use PSDDA program documents for reviewing disposal site shoreline permit applications submitted by DNR for the selected disposal sites.

b. Issue shoreline permits to DNR for the selected disposal sites for the maximum periods possible (currently 5 years) with an option for a 1-year extension.

c. Amend, as soon as practicable, local shoreline management master programs to be consistent with PSDDA recommended model shoreline master program elements for unconfined, open-water dredged material disposal (see exhibit B).

9.2.6 Other Interested Parties. Interested Puget Sound ports, Indian tribes, and other organizations will be given an opportunity to participate in the annual reviews of the PSDDA plan and have access to technical data/reports resulting from environmental monitoring of the permitted disposal sites.

9.3 Authorities. Basic authority and responsibility for decisions on the disposal of dredged material will rest with the Seattle District Engineer, Corps; the Region X Administrator, EPA; the Commissioner of Public Lands, Washington DNR; and the Director, Washington Ecology. Each agency will carry out its roles and responsibilities as defined in paragraph 9.2, under existing authorities.

9.4 Annual Review and Plan Update. As noted above, an annual review will be undertaken by the Corps, EPA, DNR, and Ecology of the PSDDA plan to assess impacts and the need for plan revisions based on both environmental and economic considerations. Other interested parties will be given an opportunity to participate in the reviews (see 9.2.6 above). Scientists and other dredged material experts may also be invited to participate. If these reviews establish that changes to the plan are appropriate, then the changes will be made by the above agencies with all interested parties notified of the changes. All plan changes will be subject to the approval of the heads of the above agencies.

9.5 Program Funding. With implementation of the PSDDA Phase II plan, ongoing dredged material regulatory functions of the agencies will continue for the Phase I plan.

Historically, the Corps and EPA have used Federal appropriations for administering dredged material disposal permits and compliance efforts. The Corps is expected to incur a small permit administration and compliance program cost increase above the level currently being experienced for the Phase I area. Ecology will similarly experience a small increase in costs for permit administration and will continue to fund its program from the State general fund. The major new program costs associated with Phase II are for the environmental baseline and monitoring studies. The Phase II environmental baseline studies, estimated to cost $248,000, were funded by Ecology ($223,000) and the Corps ($25,000).

Environmental monitoring responsibilities will be shared by the Corps and DNR. The Corps will be responsible for physical disposal site monitoring consistent with Federal requirements under Section 404. The cost for physical monitoring of Phase II sites is currently estimated at $186,900 (excluding inflation and administrative costs) over 15 years.

DNR will be responsible for chemical and biological monitoring. These costs are currently estimated at about $527,000 (excluding inflation) over 15 years. DNR will cover its administration and environmental monitoring costs through a combination of general fund requests and user fees. Expenditure of State general fund money for this purpose is appropriate since most sediment contamination was caused by upland runoff and sewage discharges rather than the marine industries doing the dredging.

The 1987 legislature authorized DNR to establish fees for management of dredged material disposal. Fees are limited to amounts necessary to cover the costs of disposal site management. The 1987 legislature also appropriated $193,000 to supplement the revenues during the FY87-89 biennium. A similar amount was appropriated for the FY89-91 biennium.

DNR disposal site fees will be based on current projections of disposal volumes and revenues and on the availability of State general funds. In 1988, DNR established PSDDA Phase I disposal site user fees at $.40/yard. It appears that, if the current level of State general fund support is continued through the FY93-95 Biennium, fees for PSDDA Phase II sites could be set near the Phase I level.

DNR will adopt regulations establishing Phase II fees prior to implementation of Phase II. The basis for the fees and a specific fee structure will be announced and submitted for public review prior to adoption. Fees will be adjusted periodically based on the availability of general fund money, actual user fee revenues and monitoring costs, and on updated projections of disposal volumes.

9.6 Economic Costs. The PSDDA Phase II plan will also have an economic impact on the private sector, Puget Sound ports, and others performing dredging activities. Even though sampling, testing, and test interpretation costs are expected to rise for some projects over costs experienced in the past, the overall impact is expected to be lower costs for dredged material disposal as more material is expected to be found acceptable for unconfined, open-water disposal than under the Puget Sound Interim Criteria (PSIC) (see chapter 2). The PSIC was governing open-water disposal in north and south Puget Sound prior to the completion of Phase II. Also, the resolution by the PSDDA study of issues associated with unconfined, openwater dredged material disposal, should reduce costly project delays.

9.7 Dispute Resolution. The Corps, EPA, DNR, and Ecology will continue to coordinate their respective activities in carrying out the Phase II plan. Resolution of any differences regarding elements of the plan will be pursued through involvement of the four agency heads, if need be. However, each agency must carry out its responsibilities in accordance with its own authorities. There is no intention through development of the PSDDA plan that these authorities be diluted, delegated, or infringed upon.

EXHIBIT A

PSDDA DREDGED MATERIAL EVALUATION PROCEDURES

PHASE I AND II AREAS

These updated procedures for sampling and evaluating dredged materials for determining the suitability of disposal in unconfined, open-water sites were prepared with participation from the Evaluation Procedures Work Group (EPWG). Significant contributions were made by:

John Wakeman, Seattle District, U.S. Army Corps of Engineers, EPWG Chair
Frank Urabeck, Seattle District, U.S. Army Corps of Engineers
David Kendall, Seattle District, U.S. Army Corps of Engineers
Keith Phillips, Washington Department of Ecology
Jim Thornton, Washington Department of Ecology
David Jamison, Washington Department of Natural Resources
Catherine Krueger, U.S. Environmental Protection Agency
John Malek, U.S. Environmental Protection Agency
Justine Smith, Seattle District, U.S. Army Corps of Engineers
Joan Hardy, U.S. Army Corps of Engineers
Scott Becker, PTI Environemntal Services, Inc.
Mike Johns, PTI Environmental Services, Inc.
Robert Pastorok, PTI Environmental Services, Inc.
Jack Ward, Battelle Northwest
Rick Cardwell, Envirosphere
Paul Dinnel, University of Washington

EXHIBIT A

PSDDA DREDGED MATERIAL EVALUATION PROCEDURES

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EXHIBIT A

PSDDA DREDGED MATERIAL EVALUATION PROCEDURES

This exhibit describes the PSDDA dredged material evaluation procedures, including sampling, chemical and biological tests, and disposal guidelines (test interpretation). In particular, sampling and analysis guidelines and chemical and biological disposal guidelines are presented. Further details are provided in the Phase I Evaluation Procedures Technical Appendix (EPTA) along with the technical basis for these guidelines. A separate user's manual for regulatory agencies, port planners and private consultants for use in planning dredging projects is being prepared by Ecology, and will be available in 1990.

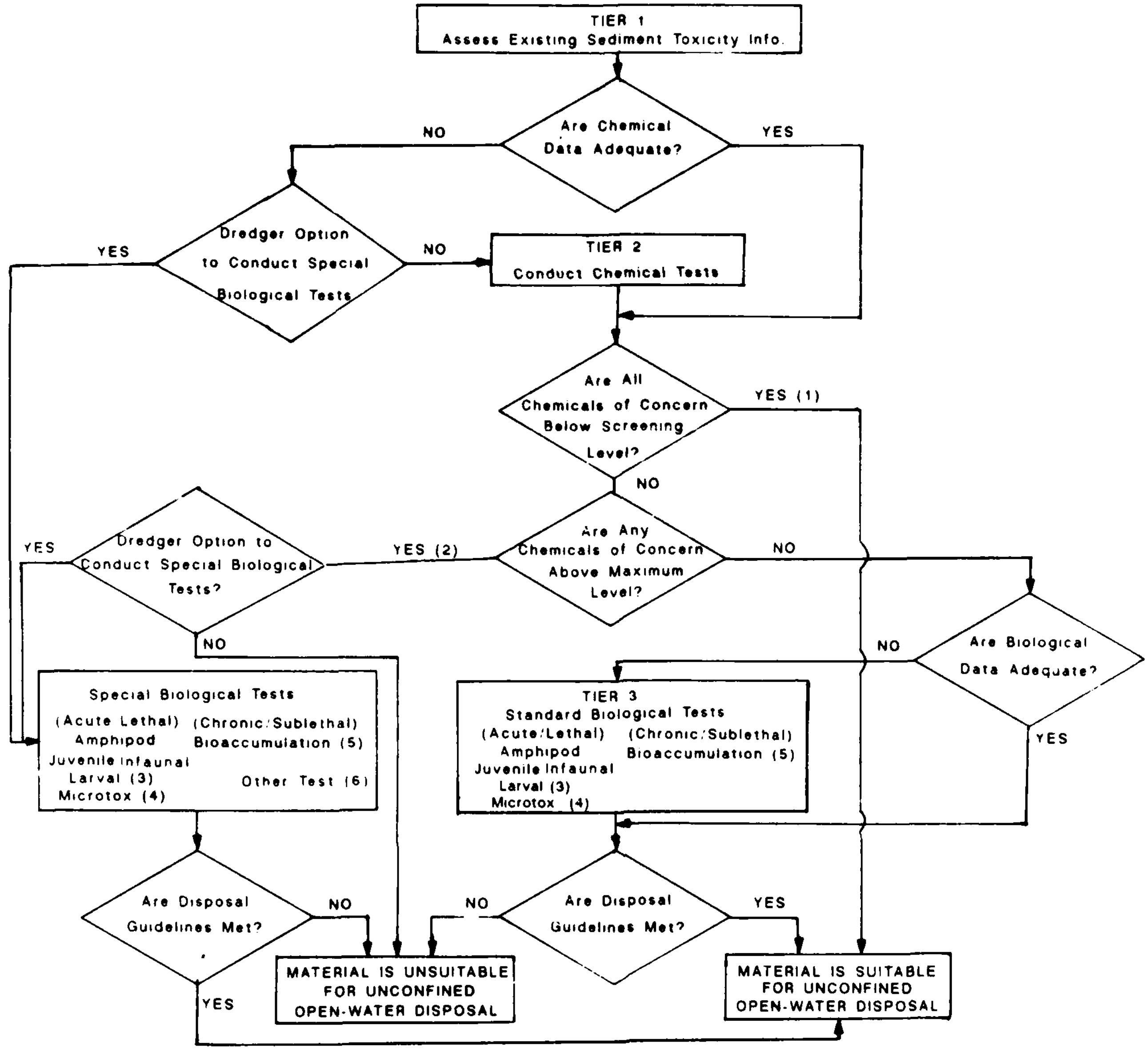
Changes may be reprinted as "change pages" to the Phase I (June, 1988) EPTA.

A series of flow diagrams of the proposed PSDDA evaluation procedures for determining the suitability of dredged material for unconfined, open-water disposal are presented in figures A.1, A.2, A.3, A.4.a, A.4.b, and A.5. The diagrams provide information on guidelines used for decisionmaking needed when testing dredged material for aquatic disposal. Figure A.1 outlines the overall tiers of the evaluation procedures and highlights the test sequence. Figures A.2 through A.5 outline the recommended disposal guidelines to be used in interpreting test results. Figures A.4.a and A.4.b expand upon figures A.2 and A.3 regarding specific interpretation pursuant to Section 401 reviews. Figure A.5 summarizes the guidelines and interpretive limits that are the PSDDA testing requirements with the completion of the Federal Record of Decision for Phase II.

1. Review of Available Data on the Project Area. An initial assessment of existing data (tier 1) is called for in the Section 404(b)(1) Guidelines to determine if there is a reason to believe that material in the proposed project contains chemicals of concern. As part of this determination, pertinent data available for the project area are reviewed. This review includes information supplied by the dredger and information developed by PSDDA agencies about the general dredging areas in Puget Sound. Available data from past dredging projects concerning the number and proximity of chemical sources to the major dredging areas was reviewed during the PSDDA study.

Where records are complete, or where available data can be used to reach a decision, testing is not required. For the many areas where this information is not available, sediment chemical testing is needed to specifically determine if the sediment contains chemicals of concern.

A key consideration in determining whether available data are adequate for project review is the recency of the information. With older data there is increased potential for a "changed condition" that could alter its validity. Data must be sufficiently recent to be considered representative of the material to be dredged. Acceptable recency is based on the number and operating status of contaminant sources near the area to be dredged, on



(1) Biological testing may still be required if there is reason to believe that the sediment is highly anomalous and may represent a significant environmental risk even though all chemicals of concern are below screening levels for unconfined open-water disposal.

(2) Standard tier 3 biological testing can still be conducted when only a single chemical of concern exceeds the maximum level by < 100% Biological testing of material with chemical levels above maximum level is allowed as an option of the dredger(see footnote 6)

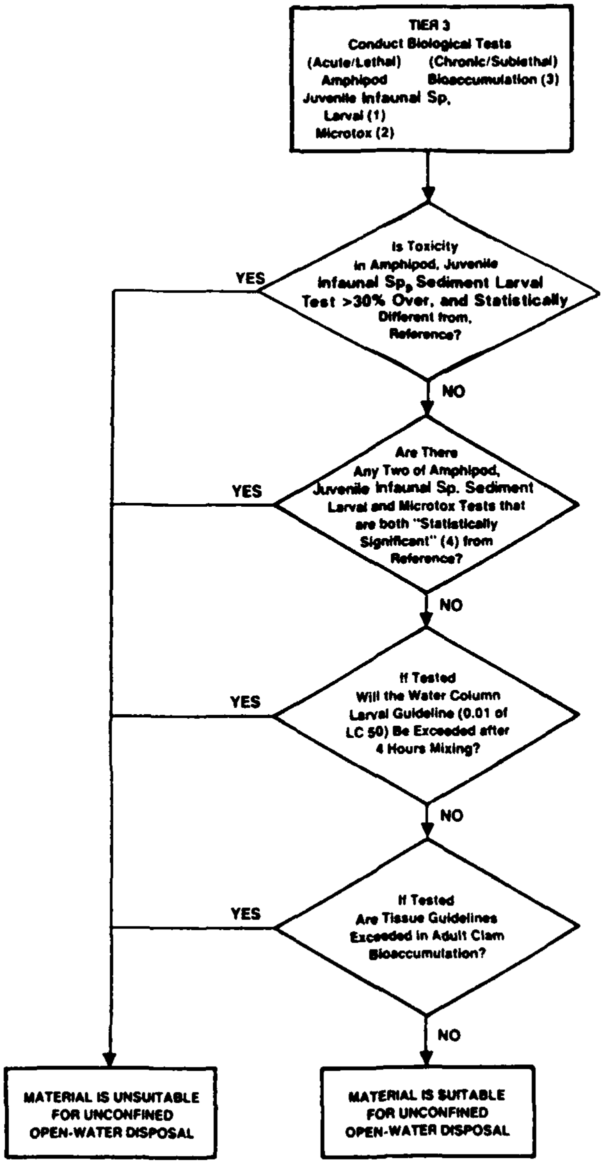
(3) The larval species can be used in either a sediment toxicity bioassay (for Section 401) and/or in a water column bioassy (for Section 404) The sediment larval test is required whenever biological testing is necessary, the water column larval test is only required when water column effects are of concern

(4) Microtox testing is required only for non-dispersive site Section 401 reviews; it is not required for non-dispersive site Section 404 evaluations, nor for either 401 nor 404 evaluations at dispersive sites.

(5) The chemical screening level that determines when bioaccumulaton testing is required is higher than for other biological testing.

(6) Special biological testing under the "Dredger Option" will include additional, more sensitive sublethal biological tests (see EPTA).

FIGURE A.1. PSDDA testing sequence.



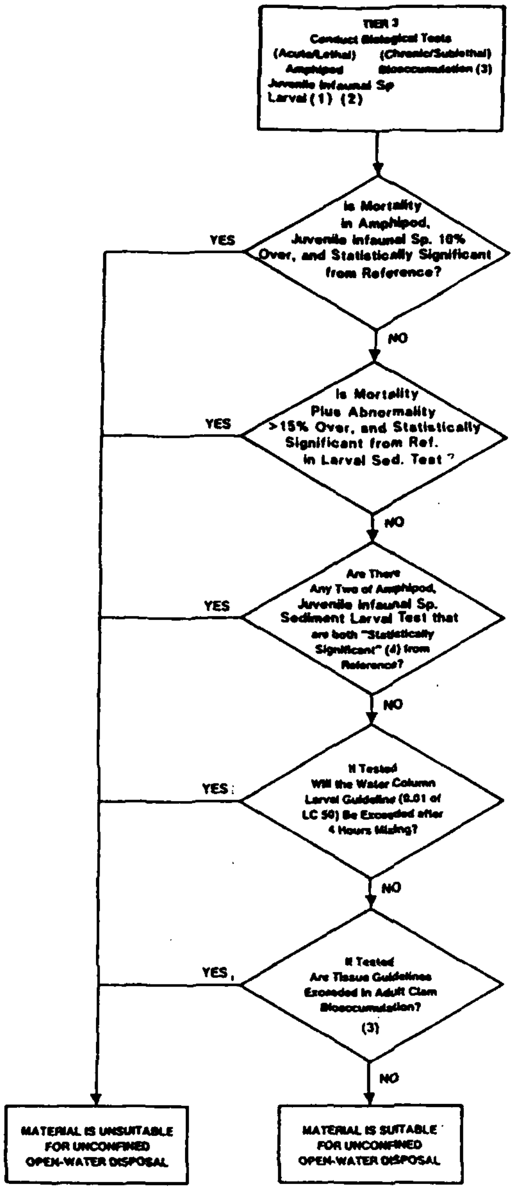
(1) The sediment toxicity larval test (for Section 401 reviews) is conducted whenever biological testing is required. The water column larval test (for Section 404 evaluations) is done only when water column effects are of concern.

(2) Microtox testing is required only for Section 401 reviews at non-dispersive sites; it is not required for Section 404 evaluations.

(3) The chemical screening level that determines when bioaccumulation testing is required is higher than for other biological testing.

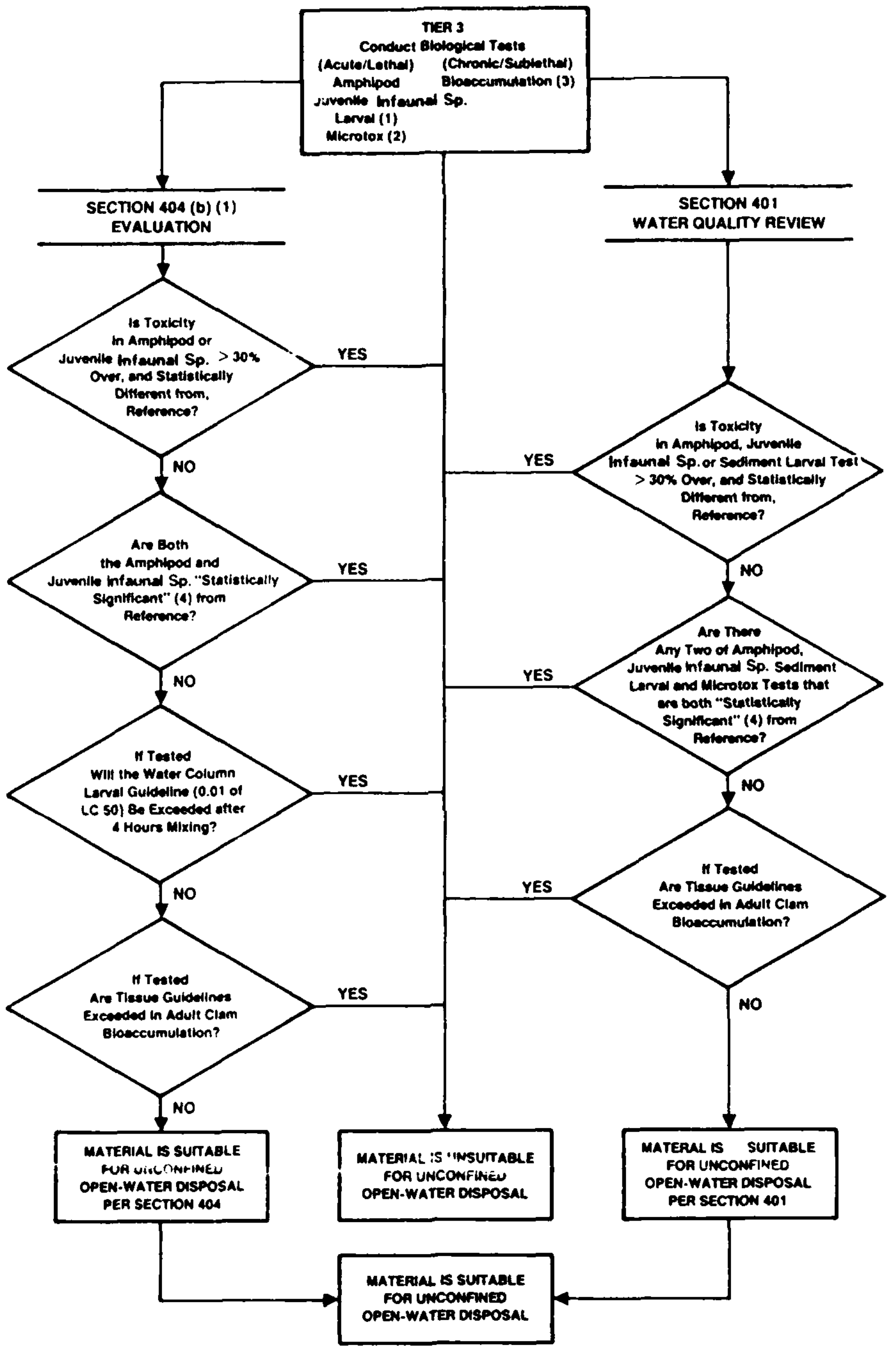
(4) "Statistically Significant" requires both a statistical difference from reference and total mortality response that is greater than 20 percent (absolute) over control.

Figure A.2 PSDDA disposal guidelines, Non-Dispersive Sites



(1) The sediment toxicity larval test (for Section 401 reviews) is conducted whenever biological testing is required. The water column larval test (for Section 404 evaluations) is done only when water column effects are of concern.
(2) Microtox testing is not required
(3) The chemical screening level that determines when bioaccumulation testing is required is higher than for other biological testing.
(4) "Statistically Significant" requires both a statistical difference from reference and total mortality response that is greater than 20 percent (absolute) over control.

Figure A.3 PSDDA disposal guidelines, Dispersive Sites



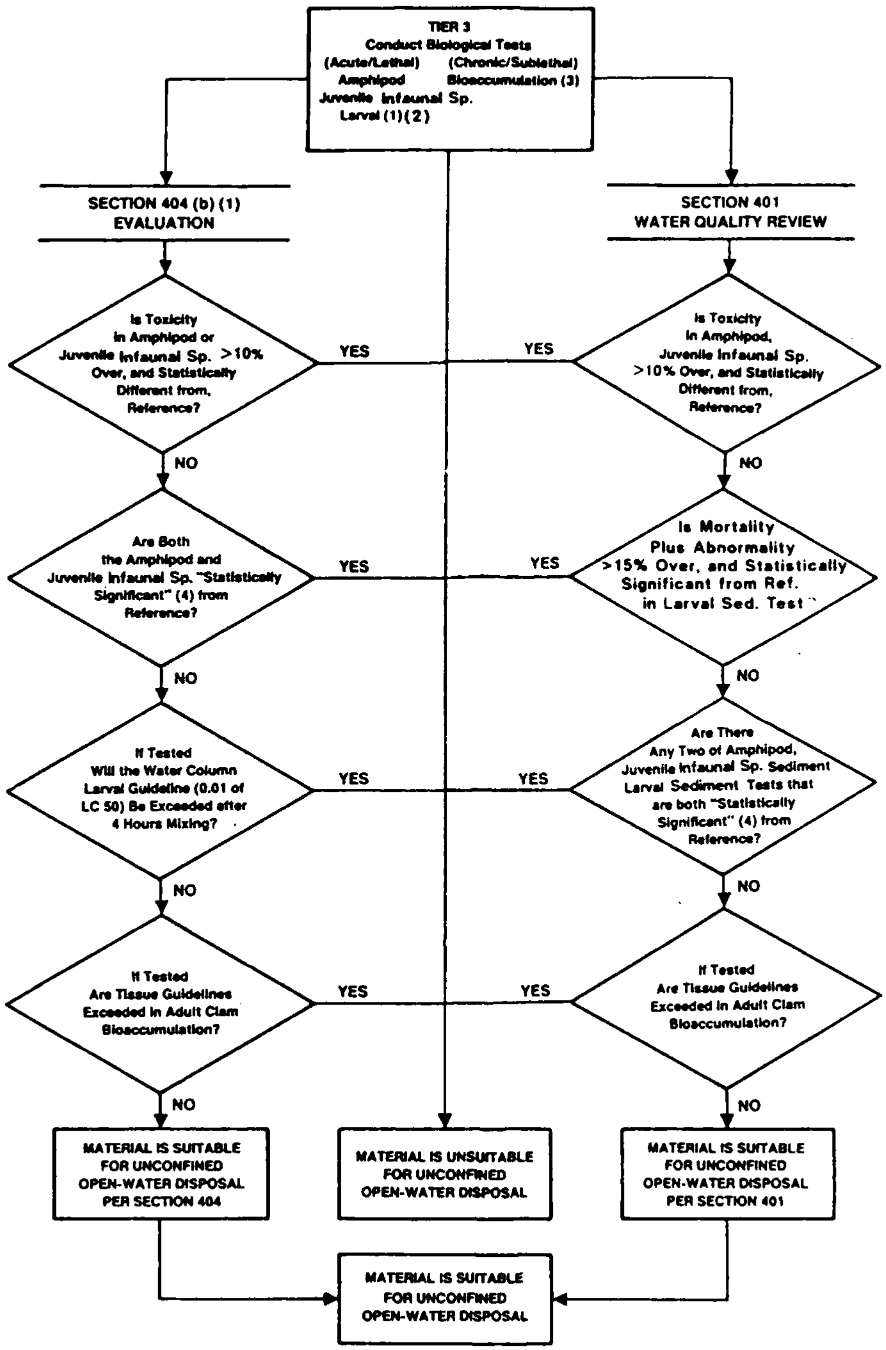
(1) The sediment larval test (for Section 401 reviews) is conducted whenever biological testing is required. The water column larval test (for Section 404 evaluations) is done only when water column effects are of concern.

(2) Microtox testing is required only for Section 401 reviews; it is not required for Section 404 evaluations.

(3) The chemical screening level that determines when bioaccumulation testing is required is higher than for other biological testing.

(4) "Statistically Significant" requires both a statistical difference from reference and total mortality response that is greater than 20 percent (absolute) over control.

Figure A.4a Section 404 and Section 401 disposal guidelines for Non-Dispersive Sites.



(1) The sediment larval test (for Section 401 reviews) is conducted whenever biological testing is required. The water column larval test (for Section 404 evaluations) is done only when water column effects are of concern.

(2) Microtox testing is not required.

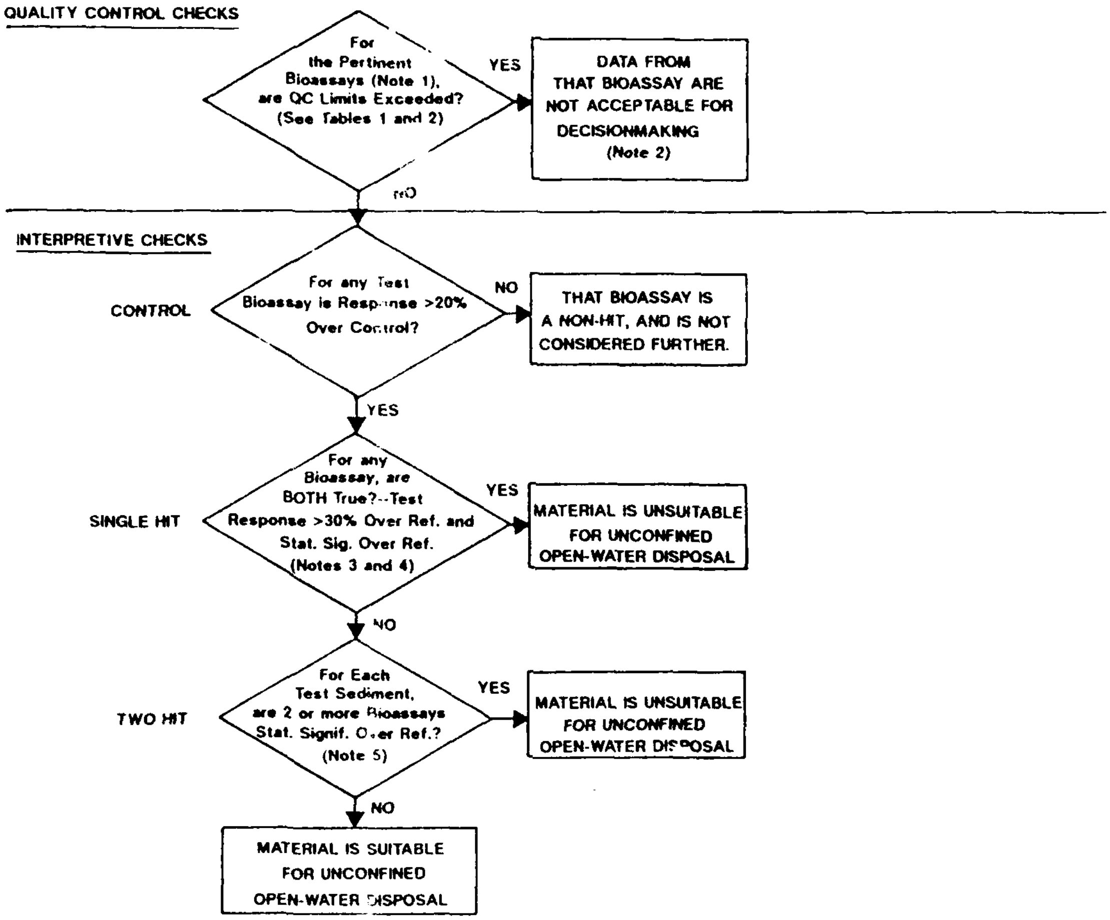
(3) The chemical screening level that determines when bioaccumulation testing is required is higher than for other biological testing.

(4) "Statistically Significant" requires both a statistical difference from reference and total mortality response that is greater than 20 percent (absolute) over control.

Figure A.4b Section 404 and Section 401 disposal guidelines for Dispersive Sites.

TABLE 1 Control Limits, Amphipod and Juvenile Infaunal Species mortality $\leq$10% absolute. Larval Sediment Test T_{final} mortality plus abnormality in Seawater Control must be $\leq$50% of $T_{initial}$ Seawater Control.

TABLE 2 Reference Limits, For all Tests; $\leq$20% Over Control. In the Case of the Amphipod, >20% may be Accepted by the PSDDA Agencies on a Case-by-Case Basis for Sediments with High Fines.



NOTE 1 At this Step in the Flow Chart, the 404 Bioassays are Amphipod and Juvenile Infaunal Species; the 401 Bioassays include Those Tests Plus the Sediment Larval Bioassay. The 404 Water Column Bivalve Larval Bioassay is Not in This Flow Chart [Microtox, a 401 Test, Enters in a Later Step (Two Hit)].

NOTE 2 If any Bioassay Fails QC Limits, it Generally Must be Rerun, Unless the PSDDA Agencies Decide to Interpret Suitability Based on Remaining Test Results.

NOTE 3 Generally a Single-tailed Student's T comparison of Mean Test Sed. response versus Mean Reference Sed. response (Ho: they are equal), alpha level of $\leq$.05

NOTE 4 This decision block refers to Nondispersive Sites (Commencement Bay, Port Gardner, Elliott Bay, Anderson-Ketron Is. and Bellingham Bay). For Dispersive Sites (Port Angeles, Port Townsend and Rosario Straits),The Single Hit rule is >10% over Reference and Statistically Significant for the Amphipod and Juvenile Infaunal Species Test, and >15% over Reference and Statistically Significant for the Sediment Larval Test.

NOTE 5(This applies to Nondispersive Sites and the Two Hit case)-Microtox is an additional 401 Test that Must be Considered at This Point. Microtox Results of the Test Sediments Must be Statistically Significant from Reference Results and >20% Below Control Response to Count as a Hit.

Figure A.5 Summary of Biological Testing Requirements.

whether the sediment is close to the sediment-water interface, and on how well previous samples described the current conditions at the project site. The recency guidelines allow the use of information for the project area to be valid for a period of 2 years for dredging surface sediments in areas with ongoing, active contaminant sources. In all other areas (i.e., surface or subsurface sediments (as defined in chapter 5), and with or without sources), it is recommended that data be considered valid for a period of 5 to 7 years.

The recency guidelines do not apply when a known "changed" condition has occurred (e.g., accidental spills or new discharges have occurred since the most recent samples were obtained). Figure A.6 provides a flow chart describing the recency guidelines. These guidelines are not considered firm rules that cannot be exceeded, but are intended to assist the regulatory process.

In order to facilitate the review of available project data, and to determine sampling and testing requirements (if applicable), dredging areas in central Puget Sound have been assigned an initial ranking based on the potential degree of contamination that could be found in the area using existing information. Four possible rankings may be assigned to a dredging area: high, moderate, low-moderate, and low. In that order, these rankings represent a scale of decreasing concern for potential contamination and a concomittant reduction in information, sampling, and analysis requirements. The ranking system was based on two factors:

a. The number and kinds of contaminant sources (existing or historic).

b. The available information on chemical and biological response characteristics of the sediments.

Characteristics of high ranking areas include many known contaminant sources, high concentrations of chemicals, and/or significant acute toxicity in sediment bioassays. Characteristics of low ranking areas include few or no contaminant sources of contamination, low chemical concentrations (typically below a level predicted to result in significant acute toxicity), and no significant response in biological tests. Sufficient data must be available to characterize the chemical and biological variable of concern for both high and low ranking areas.

A moderate ranking is assigned to areas for which data are not available or are incomplete. When a low ranking may be indicated for an area, but the data are incomplete to confirm the ranking, a ranking of "low-moderate" is assigned. In contrast, when a high ranking is indicated for an area based upon preliminary data, the area receives a "high" ranking as a protective measure. There is no ranking of "high-moderate." All other areas are ranked "moderate" except for a few very well-characterized areas (see end of table A-1). The basis for area rankings is further described in EPTA.

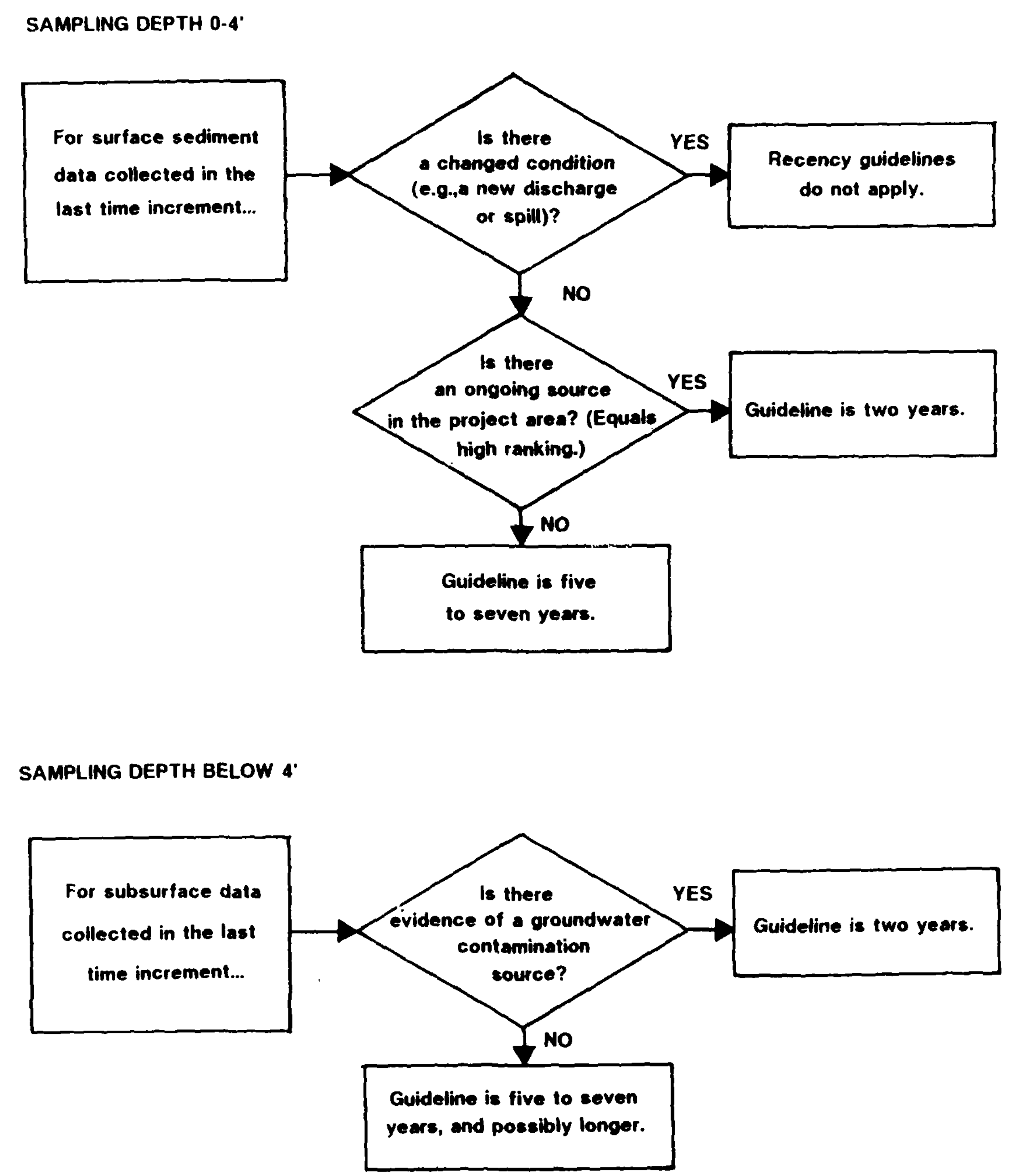


Figure A.6 Recency Guidelines Flow Chart.
This indicates the length of time that sediment data may be used for full characteration of an area or a project.

TABLE A.1

INITIAL AREA RANKINGS IN THE PHASE I STUDY AREA
(RELATIVE TO POTENTIAL FOR PRESENCE OF CHEMICALS OF CONCERN)

PHASE I AREAS:

High Rankings:
- East Waterway, Everett Harbor
- Intertidal areas of Snohomish River up to upper turning basin
- Mukilteo
- Edmonds (except at Chevron tanks)
- Kenmore
- Outer Eagle Harbor (south of the creosote plant)
- Salmon Bay
- Lake Washington ship canal
- Elliott Bay
- Duwamish River (except upper turning basin)
- Sinclair Inlet
- Commencement Bay (except Milwaukee Waterway)
- Lake Union

Moderate Rankings:
- Subtidal areas of the Snohomish River (through upper turning basin)
- West Port Susan (near Cavelero Beach)
- Ferry terminals Clinton and Gedney Island
- Chevron tanks near Edmonds
- Port Madison
- Kingston ferry terminal
- Upper terminal basin of the Duwamish River
- Lake Washington (except Kenmore)
- Dyes Inlet
- Ferry terminal at Fauntleroy
- Gig Harbor
- Upper portion of Quartermaster Harbor
- Ferry terminals at Point Defiance and Vashon Island
- Milwaukee Waterway, Commencement Bay

Low-Moderate:
- Inner Eagle Harbor (west of creosote plant)
- Outer Quartermaster Harbor
- Port Orchard

TABLE A.1 (con.)

PHASE II AREAS:

High Rankings:
- Olympia Harbor1/, Lower Budd Inlet including East Bay Marina
- Shelton
- Bellingham Harbor from the cement plant to the old disposal site and from the I and J Waterway to Post Point
- Port Angeles inside the harbor
- Port Townsend south side of point and south of marina

Moderate Rankings:
- All existing fueling and ship berthing or construction facilities
- All existing marinas except those stated as high rank
- All ferry terminals with the exception of Keystone
- Port Townsend marina
- Port Angeles Squalicum Boat Harbor
- Capsante Waterway
- Anacortes waterways, marinas and Guemes Channel

Low-Moderate Rankings:
- Lummi
- Keystone Ferry Terminal
- All other unidentified areas (except for low rank)

Low Rankings:
- Blaine (except marina)
- Oak Bay Channel
- Swinomish Channel

1/The Olympia Harbor Navigation Improvement Project, including the turning basin, is ranked as moderate and low-moderate in the entrance channel, high in the southern end of the turning basin, and the rest of the project is ranked low-moderate. Information is currently unavailable to rerank the overall Olympia area. See the following reports.

Varanasi, U., et al., 1989. Summary Report for the Olympia Harbor Navigation Improvement Project, 1988: Sediment Characterization and Microtox Assays. Report prepared for the Corps by National Marine Fisheries Service.

Varanasi, U., et al., 1988. Summary Report for the Partial Characterization for the Olympia Harbor Navigation Improvement Project, 1988. Report prepared for the Corps by National Marine Fisheries Service.

Initial rankings assigned in the Phase I study area of PSDDA are shown in table A.1. There are few active dredging areas in central Puget Sound that can be ranked initially as "low" or "low-moderate." Dredging in Phase I areas typically is in areas with many sources of contamination resulting in many of

the areas being ranked high. Additionally, past data collection efforts focused on identifying contaminated areas. Refinement of the initial rankings is allowable within a bay, within a project, and even within a dredge cut (e.g., subsurface sediments only) based on the results of sediment-specific tests.

To summarize, review of existing data from a proposed project includes information provided by the dredger that is specific to (or nearby) the project and information on the general project area that is embodied in the area's ranking. Due to lack of adequate past data, many projects will require chemical analysis to provide the basic information needed for the project. Chemical or biological testing may not be required if existing data are sufficient to determine that dredged material disposal would not result in unacceptable adverse effects.

2. Small Project Exceptions. For small projects, the cost of testing must be balanced against the environmental risks posed by a very small volume of dredged material. Very small projects often provide little reason to believe that unacceptable adverse effects are possible. As a result, the proposed volume of sediment to be removed at a dredging site, if unusually small, can obviate the need for testing.

To clearly define what constitutes a small project, two key qualifiers were developed. First, intentional partitioning of a dredging project to reduce or avoid testing requirements is not acceptable. Second, recognizing that multiple small discharges can cumulatively affect the disposal site, "project volumes" are defined in as large a context as possible. One example of this latter qualifier is recurring maintenance dredging of a small marina where "project volume" would be the summed volume over the permit life (often 5 years). Another example is multiple-project dredging contracts where a single dredging contractor conducts dredging for several projects under a single contract or contract effort. Again, the "project volume" would be summed across all projects (as would any sampling and compositing efforts prior to testing).

For very small projects in low, low-moderate, or moderate ranked areas, volumes for which no testing need be conducted, are shown in table A.2. In the absence of specific, conclusive evidence of unacceptable material, projects with these or lesser volumes would be categorically considered suitable for unconfined, open-water disposal. For low ranked areas, the "no test" volume is equal to the dredged material sampling unit (i.e., 8,000 c.y.). For low-moderate and moderate rankings, the "no test" volume of 500 c.y. is representative of the capacity of smaller barges in use in Puget Sound.

TABLE A.2

"NO TEST" VOLUMES FOR SMALL PROJECTS 1/

Area Ranking	"No Test" Volume
Low	Less than 8,000 c.y.
Low-Moderate	Less than 500 c.y.
Moderate	Less than 500 c.y.

1/Small projects that involve total volumes of dredged material less than those listed may dispose of the material at unconfined, open-water sites without testing unless specific, conclusive evidence exists demonstrating that the material is unacceptable.

For small projects (less than 500 c.y.) located in high ranked areas, some testing will be required. The dredger will have the option to conduct either a single chemical analysis for all chemicals of concern (without the required QA/QC replication), or to conduct acute bioassays (amphipod only) on a single sample (without chemistry, but with appropriate bioassay replicates). For the chemistry option, the proposed "maximum levels" would be used as "acceptable/unacceptable" values. The dredger would still have an additional option to conduct biological testing as described in chapter 5 if the material exceeded the ML values.

For small projects above the "no test" volume but less than 4,000 c.y. (except for project areas ranked low), if biological testing is needed, only a single acute bioassay (amphipod only) would be required per table A.3. For projects in low ranked areas that exceed 8,000 c.y. and require biological testing based on chemical test results, the full biological testing protocol will be followed. This is because low ranked areas are not expected to exceed the chemical "screening levels," which is one of the reasons why the "no test" volume was set so high relative to other area ratings.

3. Testing Tiers. When available information (per tier 1) indicates the need for further sampling and analysis, the following sequence of sediment testing would be performed. This sequence influences both sampling and testing. Tiering of tests can reduce costs by efficiently allocating resources for testing, but tiering also has the disadvantage of extending analyses over a longer period, potentially resulting in project delays and increasing other project-related costs.

TABLE A.3

REDUCED TESTING REQUIREMENTS FOR SMALL PROJECTS
ABOVE "NO TEST" VOLUME 1/

Area Ranking 1	Volume	Required Biological Tests 2/
Low	Less than 8,000 c.y.	No biological tests required
Low-Moderate	Greater than 500 but less than 4,000 c.y.	Single acute bioassay (amphipod)
Moderate	Greater than 500 but less than 4,000 c.y.	Single acute bioassay (amphipod)
High	Greater than 500 but less than 4,000 c.y.	Single acute bioassay (amphipod)

1/"No test" volumes are defined in table A.2.
2/Chemical tests are required of all such projects. Biological tests as listed are required if chemical results indicate that the dredged material contains chemical concentrations above the screening levels.

Biological testing of sediment to assess potential benthic (sediment toxicity) and/or water column effects is required only when chemical concentrations are within a certain range (e.g., between the screening level and maximum level), although the option exists to biologically test sediments with chemical concentrations above the maximum level. As a result, sediment testing is conducted in two tiers, one for chemical tests and one for biological (and related) tests.

4. Sampling Requirements. This section details the elements of, and rules for devising, the sampling and analysis plan required during the 404 permit process. The number of samples to be taken and the number of analyses conducted for characterizing any given project should be sufficient to allow for an adequate environmental assessment of a project as well as be cost-effective. Minimum sampling and analysis guidelines for dredged material evaluation were defined. The guidelines specify a maximum volume of dredged material that can be represented by a single sample and by a single analysis. They are considered "minimum" guidelines in that the dredger may opt, or regulatory agencies may require, additional samples or analyses if warranted.

The maximum volume of sediment that may be represented by a single sediment sample is presented in table A.4. Samples may be obtained by a number of different methods, including grabs and cores; and a single core (e.g., 12 feet in length) may be divided into several samples (e.g., three samples each 4

feet in length). For projects in areas ranked low or low-moderate, a single sediment sample will be taken for every 8,000 c.y. of material to be dredged above and below the 4-foot depth. For projects in areas ranked moderate or high, a single sediment sample will be taken for every 4,000 c.y. of material to be dredged.

In determining the number of analyses that would be required for characterizing project sediments, the concept of "dredged material management units" was used. A management unit is the smallest volume of dredged material for which a separate disposal decision can be made. Thus, a given volume of sediment can only be considered a management unit if it is capable of being dredged and managed separately from all other sediment in the project. Therefore, the decision on acceptability or unacceptability of material for unconfined, open-water disposal is made on individual management units independently of other management units within the project.

See the Phase I MPR Chapter 5 (paragraph 5.6.3) and EPTA (paragraph II-5.2.4) for a discussion of limited sampling and analysis that may be undertaken by a dredger for partial characterization of project sediments in order to achieve a lower ranking for purposes of reducing the requirements of full characterization.

Table A.5 presents the maximum volumes of sediment associated with a management unit that may be characterized by a single analysis based on area ranking and depth. For example, in a high ranking area with less than 4 feet cut depth, one analysis is required for every 4,000 c.y. of material to be dredged. In an area with a low-moderate ranking and below the 4-foot cut depth, only one analysis is required for every 48,000 c.y. of material to be dredged.

<u>It is important to note that the 4-foot cut need not be carried through to the actual dredging plan</u>. The 4-foot cut is used solely as a guideline to establish the minimum number of required samples and analyses. In developing a sampling and compositing plan, and defining dredged material management units, it is important to ensure that dredged material acceptability decisions be fully reflective of the dredging plan, i.e., <u>that the management units be truly "dredgeable</u>."

Typically, several samples will be composited to provide the material for a single analysis. The number of samples that can be composited for a single analysis is presented in table A.6. In an area with a low ranking and at less than a 4-foot cut, each analysis can represent a composite of six samples.

TABLE A.4

MINIMUM SAMPLING GUIDELINES
FOR DREDGED MATERIAL

Area Rank	Maximum Volume of Sediment Represented by Each Sample (c.y.): Volume Above 4 Foot Cut Depth	Volume Below 4 Foot Cut Depth
Low	8,000	8,000
Low-Moderate	8,000	8,000
Moderate	4,000	4,000
High	4,000	4,000

TABLE A.5

DREDGED MATERIAL MANAGEMENT UNITS 1/

Concern	Surface Sediment 4-Foot (Above Cut Depth)	Subsurface Sediment 4-Foot (Below Cut Depth)
Low	48,000	72,000
Low-Moderate	32,000	48,000
Moderate	16,000	24,000
High	4,000	12,000

1/Each management unit is the volume of sediment that may be characterized by a single analysis.

TABLE A.6

SEDIMENT ANALYSIS REQUIREMENTS

Above Ranking	Maximum Volume of Sediment Represented by Each Analysis (c.y.): Volume Above 4-Foot Cut Depth (Su.face Sediment)	Volume Below 4-Foot Cut Depth (Subsurface Sediment)	Number of Samples/ Analysis: Above	Below
Low	48,000	72,000	6	9
Low-Moderate	32,000	48,000	4	6
Moderate	16,000	24,000	4	6
High	4,000	12,000	1	3

The minimum number of samples and analyses required for a project will be determined prior to initiation of sampling. A sampling scheme would be developed based on information on the project submitted by the dredger during the initial review process. The sampling plan should be developed in close coordination with Corps, EPA, and Ecology representatives.

A proposed compositing scheme would be developed during the predredging planning process. Typically, compositing will follow the scheme outlined; however, special circumstances may warrant changes. Changes in sediment type, horizons, or lenses of material may indicate a difference in sediment which the dredger may wish to have analyzed separately. Any such change in compositing would be detailed in a formal report of the sampling and analyses program.

Several requirements and recommendations for accomplishing the sampling, compositing and analysis plan are part of the PSDDA procedures. Station location for sampling will require high positioning precision due to the link between sample locations and the need for construction-level detail in the dredging plan. Precise station positioning allows the dredging contractor to discretely remove different management units (e.g., repeatable accuracy to within ±2 m). Protocols for positioning were developed by PSDDA in conjunction with the EPA Puget Sound Estuarine Program.

Sampling with either a coring device or a grab sampler is allowed, though coring is needed if sediments below a 4-foot cut depth will be dredged. A grab sampler can be used for collecting sediment for surface management units. The core section splits (when compositing) may vary from the proposed 4-foot cut depth if a visual layer between apparently contaminated (unacceptable for unconfined, open-water disposal) and clean (acceptable for unconfined, open-water disp sal) material is seen at greater than the 4-foot depth. In such a case, the apparently contaminated material should be characterized without mixing with the cleaner material.

When a dredging project is in a high ranked area and there is no evidence of groundwater contamination, the surface left exposed after dredging could be more contaminated than the previous surface. The potential need for this analysis is discussed in EPTA (1988), page I-14. If the after-dredging surface is such that it will rapidly be covered with material similar to pre-dredging material, as when dredging is being done to develop a short-lived trench for a pipeline, this would not be a concern. However, in the case when the after-dredging surface is determined by the PSDDA agencies to be a concern, the coring that extends 1 foot into the project overdepth will be collected and archived for possible future analysis to evaluate the chemical concentration in sediments that will become the bottom surface after dredging. Archiving in this case would be used only for subsequent analyses to characterize the semivolatile organic compounds and metals. Based on the chemical holding times listed in the EPA Recommended Protocols and discussion in chapter 5, the longest holding time before chemical analysis would be 6 months since the holding time for mercury is relaxed. Chemical analyses alone will be used to compare the potential post-project surface material to the surface material. Biological testing will not be required of the archived sediments.

Samples will be tracked according to procedures developed for PSEP. Proper chain-of-custody procedures enable the samples to be followed from collection through analysis to final disposition. Documents needed to maintain proper chain-of-custody include a field logbook, sample labels and chain-of-custody records. The minimum information required in a sample tracking log includes sample identification number, location and condition of storage, date and time of each removal of and return to storage, signature of the person removing and returning the sample, reason for removing from storage, and final disposition of the sample.

5. Chemical Tests. Chemical analysis includes both the measurement of "conventional" sediment parameters and the measurement of concentrations of chemicals which PSDDA has identified as being of concern in dredged material because of the potential for unacceptable adverse effects.

"Conventional" parameters are required to be measured to further characterize the sediment in the management unit and to provide information to aid in interpreting chemical and biological tests. Conventionals that will be measured include:

- Total volatile solids.
- Grain size distribution.
- Total organic carbon.
- Percent solids.
- Total sulfides.
- Manganese.
- Ammonia.

See EPTA for a discussion of the use of data from measurement of conventionals.

Chemical testing, when required, will generally involve analysis for 58 chemicals of concern (table A.7). Table A.7 also presents the guideline values for each chemical. Use of the former and current guidelines values is discussed in section 6. The list of chemicals of concern for dredged material was developed based on a review of man-made chemicals discharged into Puget Sound. The chemicals of concern generally have the following characteristics:

- A demonstrated or suspected effect on ecology or human health (i.e., the focus of chemical concerns is on ultimate biological effects).

- One or more present or historical sources of sufficient magnitude to be of concern (i.e., a focus on widespread distribution and high concentration relative to natural conditions).

TABLE A.7

SCREENING LEVEL (SL) AND MAXIMUM LEVEL (ML)
GUIDELINE CHEMISTRY VALUES 1/
(Dry Weight Normalized)
(Changed Values are Underlined)

Chemical		EPTA (1988) SL	EPTA (1988) ML	CURRENT (1989) SL	CURRENT (1989) ML
Metals (PPM)					
	Antimony[2/]	2.6	26	20	200
	Arsenic[3/]	70	700	57	700
	Cadmium[3/]	0.96	9.6	0.96	9.6
	Copper[2/]	81	810	81	810
	Lead[3/]	66	660	6.6	660
	Mercury	0.21	2.1	0.21	2.1
	Nickel[2/]	28	120	140	
	Silver[2/]	1.2	5.2	1.2	6.1
	Zinc[2/]	160	1,600	160	1,600
	Tributyltin[4/]			30	
Organics (PPB)					
LPAH	Total	610	6,100	610	6,100
	Naphthalene	210	2,100	210	2,100
	Acenaphthylene	64	640	64	640
	Acenaphthene	63	630	63	6,300
	Fluorene	64	640	64	6,400
	Phenanthrene	320	3,200	320	3,200
	Anthracene	130	1,300	130	1,300
	2-Methylnaphthalene	67	670	67	670
HPAH	Total	1,800	51,000	1,800	51,000
	Fluoranthene	630	6,300	630	6,300
	Pyrene	430	7,300	430	7,300
	Benzo(a)anthracene	450	4,500	450	4,500
	Chrysene	670	6,700	670	6,700
	Benzofluoranthenes	800	8,000	800	8,000
	Benzo(a)pyrene	680	6,800	680	6,800
	Indeno(1,2,3-c,d)pyrene	69	5,200	69	5,200
	Dibenzo(a,h)anthracene	120	1,200	120	1,200
	Benzo(g,h,i)perylene	540	5,400	540	5,400

1/The "old" SL and ML values shown in this table were given in the 1988 PSDDA Phase I documents.

2/Value set by the total acid digest extraction method in the 1986 Puget Sound Database.

3/Value set by the strong acid digest extraction method in the 1986 Puget Sound Database.

4/Tributyltin is on the list of chemicals of concern for limited areas only. (See chapter 5.3.)

TABLE A.7 (con.)

Chemical	EPTA (1988) SL	EPTA (1988) ML	CURRENT (1989) SL	CURRENT (1989) ML
Chlorinated Hydrocarbons				
1,3-Dichlorobenzene 5/	170		170	
1,4-Dichlorobenzene	26	260	26	260
1,2-Dichlorobenzene	19	350	19	350
1,2,4-Trichlorobenzene	6.4	64	6.4	64
Hexachlorobenzene (HCB)	23	230	23	230
Phthalates 5/				
Dimethyl phthalate	160		160	
Diethyl phthalate	97		97	
Di-n-butyl phthalate	1,400		1,400	
Butyl benzyl phthalate	470		470	
Bis(2-ethylhexyl) phthalate	3,100		3,100	
Di-n-octyl phthalate	69,000		6,200	
Phenols				
Phenol	120	1,200	120	1,200
2 Methylphenol	10	72	10	72
4 Methylphenol	120	1,200	120	1,200
2,4-Dimethylphenol	10	50	10	50
Pentachlorophenol	140		69	690
Miscellaneous Extractables				
Benzyl alcohol	10	73	10	73
Benzoic acid	216	690	216	690
Dibenzofuran	54	540	54	540
Hexachloroethane	1,400	14,000	1,400	14,000
Hexachlorobutadiene	29	290	29	290
N-Nitrosodiphenylamine	22	220	22	220
Volatile Organics				
Trichloroethene	160	1,600	160	1,600
Tetrachloroethene	14	210	14	210
Ethylbenzene	10	50	10	50
Total Xylene	12	160	12	160

5/No ML has been established for these compounds (see Phase I EPTA).

TABLE A.7 (con.)

Chemical	EPTA (1988) SL	EPTA (1988) ML	CURRENT (1989) SL	CURRENT (1989) ML
Pesticides				
Total DDT	6.9	69	6.9	69
Aldrin 5/	10		10	
Chlordane 5/	10		10	
Dieldrin 5/	10		10	
Heptachlor 5/	10		10	
Lindane 5/	10		10	
Total PCB's	130	2,500	130	2,500

5/No ML is established for these compounds.

- A potential for remaining in a toxic form for a long time in the environment.

- A potential for entering the food web.

The list was pared down from the 129 priority pollutants and 30+ hazardous substances, plus the many anthropogenic chemicals found by NOAA in a study of Commencement Bay sediments.

In addition to the standard chemicals of concern, there is a limited list of chemicals of concern that need to be measured for dredging projects located near specific pollution sources. These chemicals include:

- Guaiacols.

- Chlorinated guaiacols.

- Chromium.

- Tri-, tetra-, and pentachlorobutadienes.

- Butyltins

Butyltin testing is indicated in areas near boat and vessel maintenance and construction. (See also chapter 5.c.(7) of draft Phase II MPR.) An interim SL of 30 ppb has been established for tributyltin (TBT).

Chromium appears to derive largely from the natural erosion of crustal rocks into Puget Sound, but localized sources of chromium also exist (e.g., plating industries and some chemical manufacturing facilities).

Tri-, tetra-, and pentachlorobutadienes are nonpriority pollutants that have been detected at highly elevated levels in certain areas of Puget Sound (e.g., Hylebos Waterway in Commencement Bay). Because standards are generally unavailable for these compounds, they are recommended for analysis only where chlorinated butadienes are suspected to have a major source.

Guaiacols and chlorinated guaiacols are measured in areas where kraft pulp mills are located. Only guaiacols will be measured near sulfite pulp mills (chlorinated guaiacols are not expected in processes that do not involve bleaching).

The PSDDA evaluation procedures further address compounds in areas which the State of Washington is designating (or will designate) as Clean Water Act 304(1) listed pulp and paper mills. (This section of the Act deals with discharges of toxicants and the description of the water bodies affected by the discharge.) At the present time, there are two such mills considered for listing in Puget Sound: Simpson, which empties into Commencement Bay and the Weyerheueser, in Everett, which empties into the Snohomish River.

Recent data from kraft paper mills operating in Puget Sound (EPA's 1989 National Bioaccumulation Study) indicated low but detectible concentrations of polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF's) in fish tissues collected near the points of discharge. It is possible that sediments in these same locations may also contain measurable levels of these chemicals, although no sediment data were currently available from near the discharge. PCDD's and PCDF's meet several of the PSDDA requirements for listing as chemicals of concern in dredged material. They are documented to be highly toxic, are persistent in the environment, may bioaccumulate in animal tissues, and are listed as human teratogens and carcinogens.

Dredging projects proposed for areas in the near vicinity of a Clean Water Act 304(1)-listed kraft pulp mill discharge will be required to conduct a 30-day bioaccumulation test using the *Macoma* bivalve, with tissue analysis for PCDF's and PCDD's. These chemicals are not added to the general list of chemicals of concern nor to the list of chemicals of concern for limited areas because designations of chemicals of concern imply measurement of sediment levels, and those measurements are difficult to interpret. Potential human health concerns will be addressed using this direct evidence of potential tissue concentrations that could result from sediment and water exposure to these compounds and in seafood. Should substantial levels of the compounds be observed in the clam tissue, potential for biomagnification at the PSDDA sites will be considered by the PSDDA agencies.

Sediment sampling and chemical testing procedures for sediments to be used are generally those summarized in the latest version of *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, prepared for PSEP. Metals, organics, and most sediment conventionals testing protocols will be those recommended by the PSEP for chemical analyses on Puget Sound sediments. Measurement of particle size will follow the techniques indicated

in the Recommended Protocols, but is specified to require a Number 230 (62.5 um mesh) sieve to be used in the determination of percent fines. (The American Society for Testing Materials (ASTM) sieves do not usually include this mesh size.) Ammonia analysis should be conducted according to EPA/Corps protocols. For polychlorinated dioxins and furans, the high-resolution gas chromatograph/mass spectrometer method should be used. Since dioxin-analysis methodology is changing, the dredger should consult with the PSDDA agencies at the time the sampling and analysis plan is being discussed. Reports submitted detailing chemical tests will report detection limits and report quality assurance/quality control as detailed in the following PSDDA (1989) report: Puget Sound Dredged Disposal Analysis Guidance Manual: Data Quality Evaluation for Proposed Dredged Material Disposal Projects. Prepared for the Corps and Ecology by PTI Environmental Services. Principal author: Lucinda Jacobs.

6. Chemical Disposal Guidelines. Chemical concentrations will be compared to two chemical guideline values presented in table A.7. First, a lower "screening level" (SL) has been defined for each chemical as a guideline to identify chemical concentrations below which there is no reason to believe that dredged material disposal would result in unacceptable adverse effects. For dredged material with chemical concentrations below the SL values, biological testing is not required to determine material suitability for unconfined, open-water disposal. Second, a higher "maximum level" (ML) has been defined for each chemical which corresponds to the concentration of a chemical in dredged material above which there is reason to believe that the material would be unacceptable for unconfined, open-water disposal.

When dredged material chemicals of concern exceed the ML values, the dredger has two options at this point. First, he may elect to accept the indication of the ML and conclude that the material is unsuitable for unconfined, open-water disposal. Biological testing is not required for this decision. If the dredger elects the second option, then additional, special biological testing is required as described in Phase I MPR chapter 5 (see paragraph 5.4.2).

For each management unit, the SL and ML guideline values will be used to determine whether biological testing is needed before a decision is made on the suitability for unconfined, open-water disposal. Four potential interpretations are possible:

a. All chemicals are below their SL's; no biological testing is needed; the management unit is considered suitable for unconfined, open-water disposal.

b. One or more chemicals are present at levels between SL and ML, standard biological testing (see figures A.1, A.3, and A.4) is needed.

c. A single chemical exceeds ML by less than 100% (i.e., less than twice the ML value), standard biological testing is needed.

d. A single chemical exceeds ML by more than 100% (i.e., twice the ML value) or two or more chemicals are above the ML; no biological testing is needed; there is reason to believe the management unit is unacceptable for

unconfined, open-water disposal. However, the dredger has the option to accept the indication of the ML or conduct biological testing as described in the Phase I MPR chapter 5.

7. Biological Tests Proposed Under PSDDA. Ideally, bioassessment of the potential effects of dredged material disposal would include a determination of the short- and long-term effects of environmental exposures of ecologically important species found near the disposal site to a representative sample of the material to be disposed. In practice, such bioassessment is difficult to simulate in the laboratory and is never achieved. Limitations on technical abilities to develop laboratory exposure environments and tests with benthic species found near disposal sites, and prohibitive costs in time and money to conduct such tests, makes these efforts unrealistic. Consequently, the approach most often adopted is to expose representative marine species for relatively short periods of time (10 days in acute toxicity; 30 days for bioaccumulation tests) to different phases (primarily solid phase) of whole sediment samples of the dredged material. In some cases, the species used in the assessment is commonly associated with benthic communities in and around the disposal site. More often than not, however, the species used are surrogates not found in the area of the disposal site. As a result, laboratory assessments are several steps removed ("remote") from conditions that will occur in the field. Because of the remoteness of the tests relative to the potential effects at the disposal site, the ecological meaning of the test results cannot be fully estimated at present. Therefore, though initial interpretive guidance is based on a statistical interpretation of the test results, additional professional judgment is required to determine how biological test results might relate to effects at the disposal site. To assist regions of the country in developing and interpreting bioassays relative to dredged material evaluation, the Corps and EPA produced a technical guidance manual which provides guidelines for evaluation (EPA/COE, 1977). This manual is being revised and is currently in a late draft stage. Once final, any significant changes introduced will be considered for the PSDDA program during the annual review process.

The biological testing recommendations developed by PSDDA have been designed to address both whole sediment toxicity and potential water column effects. Testing includes evaluation of sediment toxicity using the following organisms: amphipod species, juvenile infaunal species, bivalve (oyster or mussel species) or echinoderm (sand dollar or urchin species) larvae in the sediment test, and bioluminescent bacteria (the Microtox test used for CWA Section 401 requirements) (figures A.2 and A.3). The recommended tests also allow for an evaluation of potential water column effects using bivalve larvae in a different bioassay, when warranted. All of the proposed tests have been previously conducted on dredging projects within Puget Sound. Specific details on the recommended biological tests are provided in Phase I EPTA.

In several cases, the protocols used with the bioassays are described by EPA, found in the PSEP report Recommended Protocols for Conducting Bioassays on Puget Sound Sediments. For the amphipod, sediment larval, and Microtox tests, the PSEP protocols describe field collection and processing methods, QA/QC, and data reporting procedures. General protocols were provided for field collection of surficial test sediments and for general QA/QC procedures that

apply to all sediment bioassays. For those sediments in which Microtox is to be used, use of the saline extract method is required. Protocols for the larval water column test were modified from those described in the ocean disposal implementation manual, and are described in section 5.2.b of this document. A standardized method for exposing the juvenile infaunal organism, the polychaete Neanthes arenaceodentata, is described in section 5.3.d of this document.

When required, a bioaccumulation test will be conducted using an adult bivalve from the genus Macoma. The exposure duration will be 30 days after which a chemical analysis will be made of the tissue residue to determine the concentration of selected chemicals of human health concern. The bioaccumulation test will only be conducted on those dredged materials proposed for dredging in which the sediment chemistry levels are above the specified PSDDA guideline values PSDDA has established (table A.8). When required, this test will be conducted on no more than one-half of the analyses (composited samples) for any given project. Bioaccumulation data, when required, will be used to interpret potential effects to human health.

Standard protocols for the bioaccumulation test are not currently available. Procedures developed for the test will be based on bioaccumulation bioassays conducted with dredged material over the past several years. Protocols for tissue digestion and chemical analysis will follow the PSEP-recommended procedures.

For the amphipod and the juvenile infaunal species biological tests, both a control and a reference sediment will be run. (For the Microtox and larval sediment test, no sediment control is required.) The control sediment will be from the collection site of the amphipod. The control sediment is intended to provide an estimate of test organism general health during the test exposure period. In the sediment larval and Microtox tests, this measure is provided by a sea water negative control and a zero-concentration sediment extract, respectively. The reference sediment will be collected from one of the suggested reference sediment collection sites and should be compatible on a physical and grain size basis with the dredged material. The primary purpose of the reference is to determine the response of the test organisms to sediments of physical characteristics similar to the proposed dredged material. Specific reference sites are listed in EPTA and are further discussed in section 5.6 of this document, and the need for closely matching grain size in fine-grained sediments for the amphipod test is emphasized therein. For dredged material with relatively coarse-grained sediments, the dredger can opt to rely solely on a control sediment (acting as both reference and control).

Quality control limits for control treatment. For the juvenile infaunal species, larval sediment test, and amphipod acute bioassays that measure percent mortality, (that is, for all PSDDA bioassays except Microtox), both the control and the reference have test quality control or performance standards that must be met. In the amphipod and juvenile infaunal species, control mortality over the exposure period must be less than 10%

(absolute). This represents a generally accepted level of mortality of test organisms under control conditions, where the bioassay (in terms of test organism health) is still considered a valid measure of effects of the test treatments. If control mortality is greater than 10%, the bioassay must be repeated. For the larval sediment test, the performance standard for seawater negative control mortalities during the test exposure period is 50% because these more delicate planktonic larval populations have been seen to experience larger variability in laboratory settings.

TABLE A.8
SEDIMENT CHEMISTRY GUIDELINE VALUES FOR BIOACCUMULATION
(CHANGES ARE UNDERLINED)

Chemical	1988 Value 1/	Current Value
	Metals (ppm dry weight)	
Antimony	19	126
Arsenic	511	393.1
Mercury	1.5	1.5
Nickel	43	504
Silver	4	4.6
	Organic Compounds (ppb dry weight)	
Fluoranthene	4,600	4,600
Benzo(a)pyrene	4,964	4,964
1,2-Dichlorobenzene	37	37
1,3-Dichlorobenzene	1,241 2/	1,241
1,4-Dichlorobenzene	190	190
Dimethyl phthalate	1,168 2/	1,168
Di-n-butyl phthalate	10,220 2/	10,220
Bis(2-ethylhexyl) phthalate	13,870 2/	13,870
Hexachloroethane	1,022	1,022
Hexachlorobutadiene	212	212
Phenol	876	876
Pentachlorophenol	1,022	504 3/
Ethylbenzene	27	27
N-Nitrosodiphenylamine	161	161
Hexachlorobenzene	168	168
Tributyltin		219 4/
Trichloroethene	1,168	1,168
Tetrachloroethane	102	102
Total DDT	50	50
Aldrin	37 2/	37
Chlordane	37 2/	37
Dieldrin	37 2/	37
Heptachlor	37 2/	37
Total PCBs	1,789	38 5/

1/Concentration = 0.7 * (ML-SL) + SL; When the concentration of any chemical is above this value, a bioaccumulation test must be conducted on the sediment. As a result of information received during public review of the Phase I documents, several of the SL and ML values have been updated (see table A.7 for current values). The older SL and ML values were used to calculate these bioaccumulation sediment guidelines, which were left unchanged pending development of additional information and annual review of the PSDDA program.

2/These chemicals do not have an ML value. Therefore, the concentration = ((10SL-SL) * 0.7) + SL = 7.3 * SL.

3/This chemical now has a defined AET in the 1988 Puget Sound Sediment Quality Database, and an ML is now defined, as described in chapter 5, section 5.2.c.(1), so that the bioaccumulation value may be calculated.

4/Tributyltin, PCDD's and PCDF's may require bioaccumulation testing, but are not on the general PSDDA list of chemicals of concern.

5/This value is normalized to Total Organic Carbon.

Quality control limits for reference treatment. For the infaunal species test, the performance standard for the reference is not more than 20% (absolute) mortality over control during the exposure period. When mortality exceeds 20% over control in a reference sediment exposure in the juvenile infaunal species and larval sediment tests, or for the Microtox test, when the light diminution is greater than 20% over the control (zero-dilution) treatment, the bioassay must be rerun with a new sediment sample from a reference area. For the amphipod test, if mortalities in the reference sediment exceed 20% (absolute) over control, the PSDDA agencies will decide whether the test must be re-run using best professional judgment and the latest available information on Puget Sound reference areas. (The amphipod, *Rhepoxynius abronius*, has been recently shown to respond to high percent fines in sediments by exhibiting higher than 20% mortality even in clean, reference area sediments. See section 5.6 in this document for further information.)

8. Biological Response Disposal Guidelines. The response of test organisms exposed to the tested dredged material representing each management unit will be compared to the response of these organisms in both control and reference treatments during the determination of whether the material is suitable for unconfined, open-water disposal.

A determination of a "statistically significant" response, as described in EPTA (1988) and detailed in section 5.2.d and figure A.5 of this document, involves two conditions: first, that the total mortality in the tested dredged material management unit must be greater than 20% (absolute) over the control results, and second, that the results of a statistical comparison between mean test and mean reference responses must show significant difference at the alpha level of ≤ 0.05. For the latter determination, the appropriate method is a statistical single comparison which involves (a) testing using Cochran's C-test for homogeneity of variances in the test and reference treatments; (b) if they are non-zero and nonhomogeneous, arcsin-square root transformation of the data followed by retesting for homogeneity of variances; and (c) performance of a comparison test based on whether the test data are (or have been transformed to) homogeneous variances. Should the variances be zero, a nonparametric test (the Mann-Whitney U-test) is appropriate. Once variances are homogeneous, a single-tailed Student's T comparison is used to test the null hypothesis that the mean responses are equal. If they may not be made homogeneous through transformation of the data, an "approximate T" test should be used to test the null hypothesis. (Nonparametric tests may also be used, but have less statistical power.)

The interpretation of biological test results differ slightly between the Section 404(b)(1) evaluation and the Section 401 water quality certification review (figures A.4a and A.4b). The recommended disposal guidelines, including both minor differences between Sections 404 and 401 as well as the combined "net effect," are described below.

a. Test Interpretation for Section 404(b)(1) Evaluations. **Nondispersive Guideline.** Two hit: when both the amphipod and the juvenile infaunal species show "statistically significant" (see above paragraph for definition) acute toxic response relative to that of the reference sample, the materials are

judged to be unacceptable for unconfined, open-water disposal. Single hit: Alternatively, the amphipod or juvenile infaunal species response alone may serve to indicate material unsuitability. If the dredged material total mortality in either of these tests is significantly greater than the total mortality in the reference (more than 30% absolute), and if the dredged material test result is "statistically significant" relative to reference, the material is considered unacceptable for unconfined, open-water disposal.

Dispersive Guideline. Two hit: As above for the non-dispersive guideline. Single hit: Either the amphipod or juvenile infaunal species response alone may serve to indicate material unsuitability. When the dredged material mean mortality of either is significantly greater than the mean mortality in the reference (more than 10% absolute), and when the dredged material test result is "statistically significant" (see introductory paragraph above) from reference, the material is considered unacceptable for unconfined, open-water disposal.

Interpretation of the water column larval test requires an assessment of the possibility of unacceptable adverse effects occurring in the water column, although experience gained in the Corps' Dredged Material Research Program suggested that these effects are seldom seen. The appropriate assessment is described in the EPA/Corps (1977) Implementation Manual for Ecological Evaluation of Dredged Material Disposal in Ocean Waters Pursuant to Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972, Appendixes B, D, and H. The assessment is done by statistically comparing the larval survival after 96 hours in the seawater control to survival in the dredged material suspended phase exposures, including the consideration of initial mixing that might occur at the disposal site. (This statistical comparison does not require the coexisting condition of "test response greater than 20% over control" described in the paragraphs above. See the Implementation Manual.) Dredged material will be considered acceptable for unconfined, open-water disposal only if the test results and initial mixing calculations (after 4 hours) indicate the that the "limiting permissible concentration" (LPC) would not be exceeded. The LPC is the concentration of the dredged material suspended phase which, after allowance for initial mixing, will not exceed a toxicity threshold defined as 0.01 of a concentration shown to be acutely toxic to 50% of the larvae (LC_{50}). In other words, the larval test will indicate that the material is suitable for unconfined, open-water disposal if one one-hundredth (0.01) of the LC_{50} is not expected to be exceeded after 4 hours of mixing at the disposal site. Appendixes D and H of the Implementation Manual provide further details on data analysis and interpretation to be used with the water column larval test conducted pursuant to Section 404 ecological evaluations.

For the bioaccumulation test, the results are compared to guideline values to determine exceedance of allowable tissue residue concentrations. If the 30-day bioaccumulation test results in tissue levels greater than the PSDDA target tissue concentration values, the sediment is considered unacceptable for unconfined, open-water disposal.

b. Test Interpretation for Section 401 Water Quality Certification Reviews. **Nondispersive Guideline.** Two hit: If any two of four acute tests (amphipod, juvenile infaunal species, sediment larval, or Microtox bioassays) show "statistical significance" (including being >20% over control response) in the critical measure (mortality in the first three, light diminution in the last) relative to the reference sample results, the material is judged to be unacceptable for unconfined, open-water disposal. Single hit: The juvenile infaunal species, amphipod, or sediment larval mortality response alone may serve to indicate material unacceptability. If the dredged material mean mortality in any one of these three tests is more than 30% (absolute) greater than the mean mortality in the reference and the test material response is "statistically significant" relative to reference, the material is considered unacceptable for unconfined, open-water disposal. Microtox "hits" are defined as test response statistically different from reference and >20% light diminution over reference. The Microtox test results are not used to judge material acceptability *per se*. However, Microtox may be used in combination with the juvenile infaunal species, larval sediment, or the amphipod test to determine acceptability for unconfined, open-water disposal.

Dispersive Guideline. Two hit: If any two of three tests (amphipod, juvenile infaunal species, or sediment larval biossays) show "statistically significant" toxic response relative to the reference sample results, the material is judged to be unacceptable for unconfined, open-water disposal. The Microtox test result is not used in this guideline to evaluate material acceptability. Single hit: The juvenile infaunal species, amphipod, or sediment larval mortality response alone may serve to indicate material unacceptability. When the dredged material mean mortality in the juvenile infaunal species or the amphipod test is more than 10% over the mean mortality in the reference, and the test material is "statistically significant" (see introductory paragraph for explanation) relative to reference, the material is considered unacceptable for unconfined, open-water disposal. In the larval sediment test, when the dredged material test response is more than 15% over the reference test response and "statistically significant" from reference, the material is considered unacceptable for unconfined, open-water disposal.

Interpretation of bioaccumulation test results are identical to those described for the Section 404(b)(1) evaluation.

c. The "Net Effect" of Combined Test Interpretation. Section 404 and Section 401 interpretations of biological tests are identical for the amphipod, juvenile infaunal species, and bioaccumulation. The two evaluations differ in the method and interpretation of the larval sediment test, with Section 404 evaluations employ a larval test that reflects water column effects (if required) and the Section 401 evaluations use the larval test for sediment toxicity. The Microtox test results are only used in the Section 401 assessment as corroboration for "statistically significant" results in another test.

The PSDDA biological response guidelines for acceptability of material for unconfined, open-water disposal combine Section 404 and Section 401 requirements. Since all requirements must be met before dredged material can be discharged in Puget Sound waters, the dredger will be interested primarily in "net effect" of the combined requirements. These are described below.

Illustration of the two hit case. At a nondispersive site, should any two of the four tests (amphipod, juvenile infaunal species, sediment larval, or Microtox bioassays) show "statistically significant" response relative to the reference sample results, the material is judged to be unacceptable for unconfined, open-water disposal. (At dispersive sites, the Microtox test is not required.) For example, for either nondispersive or dispersive sites the following test results would indicate that the management unit is unacceptable for unconfined, open-water disposal:

juvenile infaunal species mortality (mean ±95% confidence interval)	
control:	5 ±5%
reference:	10 ±6%
dredged material:	30 ±10%

amphipod mortality (mean ±95% confidence interval)	
control:	0 ±0%
reference:	5 ±5%
dredged material:	25 ±7%

The 98% confidence values in these illustrations represent statistical significance at the alpha $\leq$ 0.05 level. In this case, the dredged material test results are 25% (absolute) over control for both the juvenile infaunal species and amphipod, exceeding the "20% (absolute) over control" guideline, and the ranges for the confidence intervals do not overlap, indicating they are significantly different.

Illustration of the single-hit case. The amphipod, juvenile infaunal species, or sediment larval mortality response alone may serve to indicate material unsuitability. At a nondispersive site, should the management unit mean total mortality of the amphipod or the juvenile infaunal species any one of these tests is greater than 30% (absolute) over mean total mortality in the reference, and if the test material is "statistically significant" relative to reference, the material is considered unacceptable. For example, the amphipod bioassay may indicate that dredged material is unacceptable for unconfined, open-water disposal as follows:

infaunal species juvenile bivalve mortality (mean ±95% confidence interval)	
control:	5 ±5%
reference:	10 ±6%
dredged material:	10 ±10%

amphipod mortality (mean ±95% confidence interval)	
control:	0 ±0%
reference:	5 ±5%
dredged material:	50 ±10%

In this case, the juvenile infaunal species test did not indicate any significant acute toxicity, but the amphipod test showed 45% (absolute) higher mean mortality than the reference and a "statistically significant" difference which included being greater than 20% over control. Thus, the material exceeds the "30% over reference" guideline. The material would also have failed the dispersive site guideline, which is more restrictive (no greater than 10% for the amphipod and juvenile infaunal species; no greater than 15% for the sediment larval test). If the dredged material amphipod response had been 21% with a ±5% confidence interval it would be (a) >20% over control mortalities; (b) statistically different from reference, and (c) more than 15% over reference, and hence would have failed.

As stated in paragraph 8a, interpretation of the water column larval test requires an assessment of the possibility of unacceptable adverse effects occurring in the water column. The water column larval test will indicate that the material is acceptable for unconfined, open-water disposal if one one-hundredth (0.01) of the concentration resulting in 50% mortality of the larvae (LC_{50}) is not expected to be exceeded after 4 hours of mixing at the disposal site.

<u>The Microtox test result alone is not used to judge material acceptability at nondispersive sites, and is not required in dispersive sites</u>. However, it may be used at nondispersive sites in combination with the other tests to determine acceptability for unconfined, open-water disposal. For purposes of corroborating other test results, a significant response for saline-extract Microtox is defined as a significant dose-response relationship of the dredged material (in the sense used in the EPA <u>Recommended Protocols</u>: determined by performing a linear regression on log light diminution <u>versus</u> log concentration and testing for significance of R^2), (b) "statistically-significant" difference of the means of five replicates of the highest concentration of extract in the reference and of the dredged material which must include a 20% (absolute) diminution in the mean dredged material response below the mean reference material response. For example, the following data would be indicative (per CWA Section 401 assessments) of an unacceptable dredged material:

<u>Microtox test results</u> (percent light relative to blank in most concentrated sediment extract) (mean ±95% confidence interval)		<u>amphipod mortality</u> (percent, absolute) (mean ±95% confidence interval	
control:	100 ±2	control:	0 ±0%
reference:	90 ±5	reference:	5 ±5%
dredged material: (and a statistically significant dose-response as shown by the dilution series)	45 ±10	dredged material:	25 ±7%

In this case, the dredged material test results are 25% (absolute) over control for the amphipod (exceeding the "20% over control" guideline), and are 50% below the reference value for Microtox (exceeding the "20% below" guideline). Both tests are statistically different from reference.

For the bioaccumulation test, the results are compared to guideline values to determine exceedance of allowable tissue residue concentrations. If the 30-day bioaccumulation test results in tissue levels greater than the target tissue concentration values in table A.9, the sediment is considered unacceptable for unconfined, open-water disposal. For several of the chemicals listed in the table, high guideline values suggest that exceedance of the guideline is unlikely. However, insufficient data are available to allow deleting these chemicals from the list at this time. It is anticipated that dredged material bioaccumulation testing will provide sufficient information in the near future to allow reduction of the list of human health chemicals of concerns.

d. The Role of Statistical Significance. The use of statistics in the data analysis phase is to identify whether observed differences of the control or reference treatments compared to the dredged material sample treatments are significant. Statistics are primarily applied in the initial data analysis stage of the PSDDA disposal guidelines. Statistical significance is used to determine if observed differences are "potentially real" when natural variability of the parameters being measured is considered. Statistics consider the accuracy and acceptability of the bioassays in indicating whether the observed differences warrant further professional evaluation. However, statistical significance does not imply ecological significance and professional judgment is essential in interpreting bioassay results.

Analysis of testing data consists of a comparison to guideline values that were developed using statistical significance as a clear indicator that toxicity was evident in the results. However, ecological significance is not always denoted by the statistics in the initial data analysis step. The subsequent data interpretation step requires both an understanding of the data evaluation procedures and professional judgment in determining the ecological

TABLE A.9

TARGET TISSUE CONCENTRATION VALUES
FOR CHEMICALS OF CONCERN TO HUMAN HEALTH

Chemical	Tissue Guidelines 1/ (ppm) (wet weight basis)
Metals	
Antimony	5,600.0
Arsenic	10.1 2/
Mercury	1.0 3/
Nickel	20,000.0
Silver	200.0
Organic Compounds	
Fluoranthene	8,400.0
Benzo(a)pyrene	1.2
1,2-Dichlorobenzene	300.0
1,3-Dichlorobenzene	300.0
1,4-Dichlorobenzene	300.0
Diethyl phthalate	300,000.0
Di-n-butyl phthalate	30,000.0
Bis(2-ethylhexyl) phthalate	18,000.0
Hexachloroethane	98.0
Hexachlorobutadine	180.0
Phenol	3,000.0
Pentachlorophenol	900.0
Ethylbenzene	600.0
N-nitrosodiphenylamine	2,845.0
Hexachlorobenzene	180.0
Trichloroethene	127.0
Tetrachloroethene	27.0
Total DDT	41.0
Aldrin	1.2
Chlordane	8.7
Dieldrin	0.46
Heptachlor	4.2
Total PCBs	2.0
Other4/	--

1/Development of the tissue guidelines is described in EPTA. The guidelines result from an exposure analysis that calculates potential transfer of chemicals of concern from the disposal site to humans via seafood consumption. The estimated low potential for this transfer results in relatively high tissue values for interpretation of lab tests.

2/Adjusted based on reported ratio of inorganic to organic arsenic (Tetra Tech, 1986a).

3/Adjusted to the FDA action level. This corrects a clerical error in Phase I EPTA and MPR.

4/Butyltins, polychlorinated dibenzodioxins and dibenzofurans are additional compounds for which bioaccumulation testing could be used. In the case of butyltins, no guideline has been derived at present. For the others, there are a variety of measures. The PSDDA agencies will use the most current guideline for these.

significance of the test results. Management of unconfined, open-water disposal may be further influenced by administrative considerations of factors such as size of the proposed discharge, the degree of environmental risk that the discharge may present, and other project specific features.

9. Reporting Requirements. Following sampling, testing, and data evaluation, the dredger for a permit application applicant must submit a formal report of the results to the Corps, EPA, and Ecology for their review. The report must:

a. identify any deviations or changes from the proposed testing plan,

b. include appropriate plan and side view drawings to show where core samples were collected and the sectioning of the cores which was undertaken, and

c. present results of chemical and biological analyses, including required QA/QC. Chemical and biological analyses summary tables must be included. (Note: The table format will be formalized after a "user manual" has been completed by Ecology (expected in 1990). This standard table will assist project review and data management.)

10. Use of Test Results in Permit Decisions. The PSDDA evaluation procedures will be applied and considered as appropriate under Sections 401 and 404 on a project-specific basis. In applying the procedures to specific projects, if the permitting agencies depart from the technical recommendations of the disposal guidelines, the permitting agencies will document the technical rationale for this departure.

11. Review of Evaluation Procedures. Because the procedures contain several features that have not received full implementation in a regulatory program prior to PSDDA, annual reviews of the evaluation procedures will be undertaken to establish if these procedures need to be further modified. In many cases during development of the procedures, data were not sufficient to fully resolve key issues, or to fully judge the impact of the proposed procedures. Consequently, the annual review process is essential to incorporate what is learned from implementation, allowing appropriate adjustments to be made.

A number of topics of concern have been identified for specific review following implementation of PSDDA. These are detailed in EPTA.

EXHIBIT B:

MODEL SHORELINE MASTER PROGRAM ELEMENT

UNCONFINED, OPEN-WATER DREDGED MATERIAL DISPOSAL

Exhibit B

Model Shoreline Master Program Element
Unconfined, Open-Water Dredged Material Disposal

Policies

A. Selection of unconfined, open-water disposal sites should follow the process developed in the Puget Sound Dredged Disposal Analysis (PSDDA) and incorporated into DNR WAC 332-30-166 Open Water Disposal Sites.

B. Unconfined, open-water disposal of dredged material should occur at the ____________ disposal site, as identified in the final Puget Sound Dredged Disposal Analysis report and adopted by the Washington Departments of Natural Resources and Ecology.

C. Due to the necessity of managing unconfined, open-water dredged material disposal on a regional basis, the ______________ disposal site will serve several jurisdictions. However, the character and total volume of material deposited on the site from all sources shall comply with the standards contained in the final PSDDA report.

D. The quality of material dumped at the _____________ disposal site shall meet the standards established in the final PSDDA study for unconfined open-water disposal and adopted by Ecology.

E. Due to the need for long-term management of open-water disposal sites, a public agency may acquire an exclusive permit for managing use of the _____________ disposal site.

F. The long term environmental impact of disposal at the ________________ site shall be monitored by the shoreline management permittee. The permittee shall provide for long-term environmental monitoring and any necessary remedies. Periodic reports on site use and environmental impact shall be submitted to the _______________ Planning Department.

Regulations

1. Unconfined, open-water disposal of dredged material shall only occur at sites identified through the process defined in the final PSDDA Study document and incorporated in DNR WAC 332-30-166 Open Water Disposal Sites.

2. The ______________ _ disposal site shall be managed in accordance

with the final PSDDA Study document and subsequent revisions.

3. General Permit Procedures

A. To assure that dredged material disposal operations are consistent with this program, no disposal of dredged materials may occur at the ________________ disposal site unless authorized by a shoreline management permit. Federal use of the site must be found to be consistent to the maximum extent practicable with the provisions of this Shoreline Management Master Program and, by reference, with the final PSDDA report.

B. It shall be the responsibility of the permit holder to assure that disposal of dredged material and management of the disposal site comply with the permit conditions and with the PSDDA report.

C. Review of applications for use of the disposal site shall be based on the criteria and guidelines established through the final PSDDA study.

3. Exclusive Use Permits

A. An exclusive permit for use of the _____________ disposal site may be issued to a public agency when that agency maintains total management control of the site. The agency shall be responsible for managing the site in accordance with the terms of the shoreline permit.

B. Yearly status reports shall be required of the agency. The reports shall state the quantity of material dumped, characterize the quality of the material, and review any other factors necessary to determine continuing compliance with the shoreline management substantial development permit. When such a permit has been issued, no other shoreline permits will be issued for use of the site without permission of the site managing agency.

C. The term for exclusive site management permits issued to public agencies will be five years with a one year extension option, unless a shorter term is requested by the agency. However, if longer permit terms are allowed by the Department of Ecology, the permit term shall be indefinite. This indefinite term shall be contingent on inspection and environmental monitoring programs established in accordance with the final PSDDA report to ensure that environmental impacts are as predicted.

EXHIBIT C

DISPOSAL SITE MANAGEMENT PLANS FOR UNCONFINED, OPEN-WATER, DREDGED MATERIAL DISPOSAL SITES

PHASE II AREA - NORTH AND SOUTH PUGET SOUND

These management plans were prepared by the Management Plan Work Group whose members are:

Steve Tilley, Work Group Chairman, Washington Department of Natural Resources

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PSDDA PHASE II
DISPOSAL SITE MANAGEMENT PLANS

1. Anderson/Ketron Islands

1.1 Disposal Goals

The goals of Anderson/Ketron Islands disposal site management are to ensure that appropriate dredged materials are placed accurately, in accordance with any project requirements, and that long term environmental impacts of disposal are known to be acceptable.

1.2 Future Dredged Material Disposal Volumes

The total volume of dredged material projected to be sent to the Anderson/Ketron Islands disposal site is between 217,500 and 785,000 cubic yards over the next 15-year period (Table 1). The wide variation is due to the possibility of a large project in Olympia. For planning purposes, it is assumed that 217,500 cubic yards total will be sent to the site. Volume during the first four years is projected at a low level due to the lack of firm near-term projects (Table 2).

1.3 Disposal Target Area

The disposal target area is a circle with a 600′ radius centered at Latitude 47 degrees 09.43′ and Longitude 122 degrees 39.40′. This area will be specified in all permits issued for disposal at this site. The 600′ radius is an achievable positioning goal given the methods specified for this disposal site in Section 1.4 below. However, it is recognized that intricate positioning of tug and barge combinations is difficult. Disposal must not begin until at least some part of the barge is within the target area and end before the entire barge leaves the target area. This margin for error is built into sizing of the 900′ radius surface disposal zone. Disposal will be acceptable if some part of the barge is within the 600′ target area. However, the entire barge must be within the disposal zone throughout the time of dredged material release.

1.4 Navigation Controls

Disposal site users will be required to provide disposal site plans before receiving Corps and DNR permit approvals. The plans will demonstrate the users have the capability to position accurately with approved methods.

For large projects, it may be desirable to establish a buoy at the site. This would be done in consultation with affected fishers, pilots, boaters, Federal and state agencies and others.

1.5 Debris Control

Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation

or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the site assessment indicates the presence of log debris or other debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this can not be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh). The contractor shall maintain a daily record of debris encountered. The daily record should describe the operator's name, size, type, and method of disposal.

1.6 Site Use Reporting

Disposal site users will be required to complete the DNR Site User Log (Figure 1) for each use of the disposal site. Copies of the site use records shall be submitted to DNR at least once per month. Copies of the records shall also be retained on the tug for one month.

1.7 Compliance Inspection

Only dredged material meeting the PSDDA guidelines may be disposed of at the site. Compliance will be ensured through pre-dredging testing of dredged material and through inspection of dredging operations.

Dredging site inspection plans for non-Corps projects will be prepared by Ecology. The plans will define inspection necessary to assure the quality of material sent to open-water disposal and compliance with the contractors' approved plan for debris removal. Ecology and the Corps will coordinate inspections for compliance by non-Corps projects and the Corps will inspect its own contractors. Copies of all Ecology and Corps dredging site inspection plans will be forwarded to DNR before dredging begins.

Prior to permit issuance, dredgers will be required to submit disposal site use plans covering positioning, debris handling, timing and other site use factors. DNR and the Corps will periodically inspect non-Corps projects for compliance with these plans (as modified by permit conditions).

TABLE 1
ESTIMATED VOLUME BY SITE OVER NEXT FIFTEEN YEARS

	Port Angeles	Port Townsend	Rosario	Bellingham	Anderson/ Ketron Is.
Total Volume	285,000	687,000	1,801,000	1,181,500	785,000
Adjustment	(142,000)[1]	(528,000)[2]	(486,000)[3]	(631,000)[4]	(567,500)[5]
Adjusted Total	143,000	159,000	1,315,000	550,500	217,500
Ave. Annual Vol.	9,533	10,600	87,667	36,700	14,500

[1]Half of total deducted to allow for projects where material may be more economically placed elsewhere.
[2]Proposed port marina expansion (373,000) and half of balance (45,000 + 121,000 + 144,000) deducted to allow for projects where material may be more economically placed elsewhere.
[3]Proposed Blaine expansion (350,000) and an additional 136,000 are deducted to allow for projects where material may be more economically placed elsewhere. The latter figure is half the non-Swinomish Channel balance.
[4]Lummi Bay maintenance (80,000) and half of the balance (1,101,500) deducted to allow for projects where material may be more economically placed elsewhere.
[5]Proposed West Bay improvement (350,000) and half the balance (435,000) deducted to allow for projects where material may be more economically placed elsewhere.

TABLE 2
ANNUAL VOLUME ESTIMATES OVER NEXT FIFTEEN YEARS*

Year	Port Angeles	Port Townsend	Rosario	Bellingham	Anderson/ Ketron Is.
1 (FY 90)					
2				230,000	
3	11,000	12,231	10,000	26,192	16,731
4	11,000	12,231	10,000	26,192	16,731
5-15 (Annual)	11,000	12,231	117,727	26,192	16,731
TOTAL	143,000	159,000	1,315,000	550,500	217,500

*The first two years are based on known projects. The remaining years (except at Rosario) have been projected on an even-flow basis. Volume at Rosario will be heavily impacted by the Corps' Swinomish Channel dredging which has been spread over years 5-15 in this table.

FIGURE 1

DISPOSAL SITE USER LOG (EXAMPLE)

DISPOSAL SITE__________ SITE CENTER: Lat________, Long________, SITE RADIUS 600'

TUG NAME__________

	DATE	DNR PERMIT #	BARGE NAME	BEGIN DUMPING		END DUMPING		VOLUME (CU. YD.)	DESCRIBE FLOATABLES REMOVED	TIME LEFT SITE	SKIPPER'S SIGNATURE
				TIME	BEARING AND RANGE (FROM CENTER OF SITE)	TIME	BEARING AND RANGE (FROM CENTER OF SITE)				
1											
2											
3											

COAST GUARD DISPOSAL SITE USE LOG (EXAMPLE)

DISPOSAL SITE__________

TUG NAME__________

	DATE	DNR PERMIT #	BARGE NAME	TIME		ON SITE DURING DISPOSAL YES?/NO	LOCATION OF DISPOSAL IF OFF SITE BEARING AND RANGE FROM CENTER	SIGNATURE
				BEGIN DUMPING	END DUMPING			
1								
2								
3								

TABLE 3

ANTICIPATED SCHEDULE FOR BASELINE STUDIES AND ENVIRONMENTAL MONITORING AT EACH DISPOSAL SITE OVER THE 15-YEAR MONITORING PERIOD[1]

	------ Phase II ------			----- Phase I -----		
FISCAL YEAR	Bellingham Bay	Anderson/ Ketron Is.	Dispersive Sites	Port Gardner	Elliott Bay	Commencement Bay
1988				B	B	B
1989	B	B	B			
1990					F	F
1991	F			F		
1992						
1993				F	F	F
1994			Ph			
1995	P				P	
1996						
1997		F				
1998				P		P
1999	F		Ph		P	
2000						
2001						
2002						
2003						
2004	P	P	Ph	P	P	P

B = Baseline Monitoring
F = Full Monitoring
P = Partial Monitoring
Ph = Physical Monitoring

[1]Monitoring efforts will only take place after the sites have been used and volumes are sufficient to reasonably expect that observable changes will be present. Dispersive sites (Port Angeles, Port Townsend, and Rosario Strait) will receive physical monitoring only. This table shows updated anticipated monitoring schedules for Phase I sites.

The Corps will inspect disposal site positioning and debris removal for Corps projects and keep disposal site use records similar to those kept by dredgers for non-Corps projects. Copies of these records and of Corps inspection reports will be periodically sent to DNR.

1.8 Site Use Restrictions

There are no blanket restrictions on disposal site use for noise or navigation impacts at the Anderson/Ketron Islands disposal site. However, individual permits may be conditioned for these or other factors.

1.9 Environmental Monitoring

The Anderson/Ketron Islands site is in a relatively flat, generally nondispersive area with a depth of 442' at the center of the disposal zone. The area is subject to weak currents. In general, commercially important marine invertebrate resources are scarce or absent within the site and are usually concentrated up-slope in shallower nearshore areas. Tidal currents should not significantly alter the disposal site configuration and bottom slopes may help confine the disposal material. Therefore, the site forms an ellipse 4400' by 3600' with the long axis oriented with the current.

Table 3 summarizes the estimated fifteen-year monitoring schedule for the Phase II area disposal sites. As shown, the Anderson/Ketron Islands site is anticipated to receive full monitoring in 1997 and partial monitoring in 2004.

2. Bellingham Bay

2.1 Disposal Goals

The goals of Bellingham Bay disposal site management are to ensure that appropriate dredged materials are placed accurately, in accordance with any project requirements, and that long term environmental impacts of disposal are known to be acceptable.

2.2 Future Dredged Material Disposal Volumes

The total volume of dredged material projected to be sent to the Bellingham Bay disposal site is between 550,500 and 1,181,500 cubic yards over the next 15-year period (Table 1). The wide variation is due to the uncertainty in several major projects. For planning purposes, it is assumed that 550,500 cubic yards total will be sent to the site (Table 2).

2.3 Disposal Target Area

The disposal target area is a circle with a 600' radius centered at Latitude 48 degrees 42.83' and Longitude 122 degrees 33.03'. This area will be specified in all permits issued for disposal at this site. The 600' radius is an achievable positioning goal given the methods specified for this disposal site in Section 2.4 below. However, it is recognized that intricate

positioning of tug and barge combinations is difficult. Disposal must not begin until at least some part of the barge is within the target area and end before the entire barge leaves the target area. This margin for error is built into sizing of the 900' radius surface disposal zone. Disposal will be acceptable if some part of the barge is within the 600' target area. However, the entire barge must be within the disposal zone throughout the time of dredged material release.

2.4 Navigation Controls

Disposal site users will be required to provide disposal site plans before receiving Corps and DNR permit approvals. The plans will demonstrate the users have the capability to position accurately with approved methods.

2.5 Debris Control

Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the site assessment indicates the presence of log debris or other debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this can not be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh). The contractor shall maintain a daily record of debris encountered. The daily record should describe the operator's name, size, type, and method of disposal.

2.6 Site Use Reporting

Disposal site users will be required to complete the DNR Site User Log (Figure 1) for each use of the disposal site. Copies of the site use records shall be submitted to DNR at least once per month. Copies of the records shall also be retained on the tug for one month.

2.7 Compliance Inspection

Only dredged material meeting the PSDDA guidelines may be disposed of at the site. Compliance will be ensured through pre-dredging testing of dredged material and through inspection of dredging operations.

Dredging site inspection plans for non-Corps projects will be prepared by Ecology. The plans will define inspection necessary to assure the quality of material sent to open-water disposal and compliance with the contractors' approved plan for debris removal. Ecology and the Corps will coordinate inspections for compliance by non-Corps projects and the Corps will inspect its own contractors. Copies of all Ecology and Corps dredging site inspection plans will be forwarded to DNR before dredging begins.

Prior to permit issuance, dredgers will be required to submit disposal site use plans covering positioning, debris handling, timing and other site use factors. DNR and the Corps will periodically inspect non-Corps projects for compliance with these plans (as modified by permit conditions).

The Corps will inspect disposal site positioning and debris removal for Corps projects and keep disposal site use records similar to those kept by dredgers for non-Corps projects. Copies of these records and of Corps inspection reports will be periodically sent to DNR.

2.8 Site Use Restrictions

Due to potential impacts on Dungeness crab, the Bellingham Bay site will be closed between November 1 and February 28 each year. Additionally, the fisheries closure between March 15 and June 15 each year would effectively limit disposal of dredged material to between June 16 and October 31 each year.

A portion of the Bellingham Bay site is within a designated explosives anchorage area. According to 33 CFR 110.230 "Fishing and navigation by pleasure and commercial craft are prohibited within the area at all times when vessels which are anchored in the area for the purpose of loading or unloading explosives display a red flag by day and a red light by night, unless special permission is granted by the Captain of the Port." The Coast Guard has approved use of this site during periods when explosives vessels are not anchored. When any vessel is anchored in the explosives anchorage area, disposal site users must contact the Captain of the Port and receive permission before using the site (letter from J.R. Felton, Captain of the Port of Puget Sound to Frank Urabeck, October 7, 1988 see Exhibit D of Phase II FEIS).

2.9 Environmental Monitoring

The Bellingham Bay site is in a relatively flat, generally nondispersive area with a depth of about 96' and is subject to sluggish tidal currents. Crab and shrimp resource abundances were found to be lowest between July and October when dredging and disposal would be allowed.

Table 2 summarizes the estimated fifteen-year monitoring schedule for the Phase II area disposal sites. As shown, the Bellingham Bay site is anticipated to receive full monitoring in 1991 and 1999 and partial monitoring in 1995 and 2004.

3. Port Townsend

3.1 Disposal Goals

The goals of Port Townsend disposal site management are to ensure that appropriate dredged materials are placed accurately, in accordance with any project requirements, and that long term environmental impacts of disposal are known to be acceptable.

3.2 Future Dredged Material Disposal Volumes

The total volume of dredged material projected to be sent to the Port Townsend disposal site is a range of 159,000 to 687,000 cubic yards over the next 15-year period. The wide variation is due to uncertainty about a port marina expansion in Port Townsend. For planning purposes, it is assumed that 159,000 cubic yards total will be sent to the site. Volume during the first four years is projected at a low level due to the lack of firm near-term projects (Table 2). Actual volumes will depend on actual dredging projects and results of chemical and biological tests.

3.3 Disposal Target Area

The disposal zone (and target area) is a circle with a 1500′ radius centered at Latitude N 48 degrees 13.62′ and Longitude W 122 degrees 59.95′. This area will be specified in all permits issued for disposal at this site.

The 1500′ radius is believed to be adequate for average conditions at the site. A barge travelling at 2 knots (3.4 ft/sec) relative to the water and, with a 1 knot current, travelling 3 knots relative to the bottom (5.06 ft/sec) would cross a 3000′ diameter circle in 10 minutes. In some cases, wind or current conditions at the site could require adjustments to stay within the 3000′ circle or delaying disposal if conditions are extreme.

3.4 Navigation Controls

The official positioning aid for the Port Townsend disposal site is the Coast Guard Vessel Traffic Service (VTS). All site users must contact the VTS and obtain positioning confirmation before initiating disposal. However, Loran-C coordinates will be provided to aid operators in positioning.

3.5 Debris Control

Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the site assessment indicates the presence of log debris or other debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this can not be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh). The contractor shall maintain a daily record of debris encountered. The daily record should describe the operator's name, size, type, and method of disposal.

3.6 Site Use Reporting

Disposal site users will be required to complete the DNR Site Use Log (Figure 1) for each use of the disposal site. Copies of the site use records shall be submitted to DNR at least once per month. Copies of the records shall also be retained on the tug for one month.

3.7 Compliance Inspection

Only dredged material meeting the PSDDA guidelines may be disposed of at the site. Compliance will be ensured through pre-dredging testing of dredged material and through inspection of dredging operations.

Dredging site inspection plans for non-Corps projects will be prepared by Ecology. The plans will define inspection necessary to assure the quality of material sent to open-water disposal and compliance with the contractors' approved plan for debris removal. Ecology and the Corps will coordinate inspections for compliance by non-Corps projects and the Corps will inspect its own contractors. Copies of all Ecology and Corps dredging site inspection plans will be forwarded to DNR before dredging begins.

Prior to permit issuance, dredgers will be required to submit disposal site use plans covering positioning, debris handling, timing and other site use factors. DNR and the Corps will periodically inspect non-Corps projects for compliance with these plans (as modified by permit conditions).

The Corps will inspect disposal site positioning and debris removal for Corps projects and keep disposal site use records similar to those kept by

dredgers for non-Corps projects. Copies of these records and of Corps inspection reports will be periodically sent to DNR.

Disposal site positioning accuracy will be verified for each use by the Coast Guard Vessel Traffic Service (VTS). Site users will be required to contact the Coast Guard before disposal to confirm positioning and to report the tug, barge, and skipper's names, DNR permit number, and the time dumping begins. Site users must also report the time disposal ends. The Coast Guard will contact any vessels which appear to be making improper use of the site. This could include improper timing, lack of permits, use of improper equipment, or inaccurate positioning. If improper use is discovered, the Coast Guard will:

a. Tell the operator why and advise them to stop;

b. Record the type of improper use and ask the source and yardage of material and name of project employer (if disposal has already occurred); and

c. Notify DNR immediately or on the next working day.

The Coast Guard will maintain a record of all contacts with vessels using the disposal site. A copy of the record will be sent to DNR weekly. DNR will provide the Coast Guard with the following:

a. A statement of any site use restrictions for which violations could be identified through VTS;

b. Names and permit numbers of all tugs and barges authorized to use the site; and

c. Work and off-hours phone numbers for emergency contacts in case a violation is discovered in-progress and advice is needed.

3.8 <u>Site Use Restrictions</u>

There are no blanket restrictions on disposal site use for noise or navigation impacts at the Port Townsend disposal site. However, individual permits may be conditioned for these or other factors.

3.9 <u>Environmental Monitoring</u>

The Port Townsend Disposal Site has a site center depth of 361'. Due to strong currents in the area, dredged material is expected to be moved off the site within a few days. Therefore, physical monitoring will be conducted to verify the absence of mounds on the bottom but no biological or chemical monitoring will be performed. Table 2 summarizes the estimated fifteen year monitoring schedule.

4. Port Angeles

4.1 Disposal Goals

The goals of the Port Angeles disposal site management are to ensure that appropriate dredged materials are placed accurately, in accordance with any project requirements, and that long term environmental impacts of disposal are known to be acceptable.

4.2 Future Dredged Material Disposal Volumes

The total volume of dredged material projected to be sent to the Port Angeles disposal site is a range of 143,000 to 285,000 cubic yards over the next 15-year period. For planning purposes, it is assumed that 143,000 cubic yards total will be sent to the site. Volume during the first four years is projected at a low level due to the lack of firm near-term projects (Table 2). Actual volumes will depend on actual dredging projects and results of chemical and biological tests.

4.3 Disposal Target Area

The disposal zone (and target area) is a circle with a 1500′ radius centered at Latitude N 48 degrees 11.68′ and Longitude W 123 degrees 24.86′. This area will be specified in all permits issued for disposal at this site.

The 1500′ radius is believed to be adequate for average conditions at the site. A barge travelling at 2 knots (3.4 ft/sec) relative to the water and, with a 1 knot current, travelling 3 knots relative to the bottom (5.06 ft/sec) would cross a 3000′ diameter circle in 10 minutes. In some cases, wind or current conditions at the site could require adjustments to stay within the 3000′ circle or delaying disposal if conditions are extreme.

4.4 Navigation Controls

The official positioning aid for the Port Angeles disposal site is the Coast Guard Vessel Traffic Service (VTS). All site users must contact the VTS and obtain positioning confirmation before initiating disposal. However, Loran-C coordinates will be provided to aid operators in positioning.

4.5 Debris Control

Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of

log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the site assessment indicates the presence of log debris or other debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this can not be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh). The contractor shall maintain a daily record of debris encountered. The daily record should describe the operator's name, size, type, and method of disposal.

4.6 Site Use Reporting

Disposal site users will be required to complete the DNR Site Use Log (Figure 1) for each use of the disposal site. Copies of the site use records shall be submitted to DNR at least once per month. Copies of the records shall also be retained on the tug for one month.

4.7 Compliance Inspection

Only dredged material meeting the PSDDA guidelines may be disposed of at the site. Compliance will be ensured through pre-dredging testing of dredged material and through inspection of dredging operations.

Dredging site inspection plans for non-Corps projects will be prepared by Ecology. The plans will define inspection necessary to assure the quality of material sent to open-water disposal and compliance with the contractors' approved plan for debris removal. Ecology and the Corps will coordinate inspections for compliance by non-Corps projects and the Corps will inspect its own contractors. Copies of all Ecology and Corps dredging site inspection plans will be forwarded to DNR before dredging begins.

Prior to permit issuance, dredgers will be required to submit disposal site use plans covering positioning, debris handling, timing and other site use factors. DNR and the Corps will periodically inspect non-Corps projects for compliance with these plans (as modified by permit conditions).

The Corps will inspect disposal site positioning and debris removal for Corps projects and keep disposal site use records similar to those kept by dredgers for non-Corps projects. Copies of these records and of Corps inspection reports will be periodically sent to DNR.

Disposal site positioning accuracy will be verified for each use by VTS. Site users will be required to contact the Coast Guard before disposal to confirm positioning and to report the tug, barge, and skipper's names, DNR permit number, and the time dumping begins. Site users must also report the

time disposal ends. The Coast Guard will contact any vessels which appear to be making improper use of the site. This could include improper timing, lack of permits, use of improper equipment, or inaccurate positioning. If improper use is discovered, the Coast Guard will:

a. Tell the operator why and advise them to stop;

b. Record the type of improper use and ask the source and yardage of material and name of project employer (if disposal has already occurred); and

c. Notify DNR immediately or on the next working day.

The Coast Guard will maintain a record of all contacts with vessels using the disposal site. A copy of the record will be sent to DNR weekly. DNR will provide the Coast Guard with the following:

a. A statement of any site use restrictions for which violations could be identified through VTS;

b. Names and permit numbers of all tugs and barges authorized to use the site; and

c. Work and off-hours phone numbers for emergency contacts in case a violation is discovered in-progress and advice is needed.

4.8 Site Use Restrictions

There are no blanket restrictions on disposal site use for noise or navigation impacts at the Port Angeles disposal site. However, individual permits may be conditioned for these or other factors.

4.9 Environmental Monitoring

The Port Angeles Disposal Site lies at a depth of about 435'. Due to strong currents in the area, dredged material is expected to be moved off the site within a few days. Therefore, physical monitoring will be conducted to verify the absence of mounds on the bottom but no biological or chemical monitoring will be performed. Table 2 summarizes the estimated fifteen year monitoring schedule.

5. Rosario Strait

5.1 Disposal Goals

The goals of the Rosario Strait disposal site management are to ensure that appropriate dredged materials are placed accurately, in accordance with any project requirements, and that long term environmental impacts of disposal are known to be acceptable.

5.2 Future Dredged Material Disposal Volumes

The total volume of dredged material projected to be sent to the Rosario Strait disposal site is a range of 1,315,000 to 1,801,000 cubic yards over the next 15-year period (Table 1). The variation is due to uncertainty of the proposed Blaine expansion and other minor projects. For planning purposes, it is assumed that 1,315,000 cubic yards total will be sent to the site. Actual volumes will depend on actual dredging projects and results of chemical and biological tests.

5.3 Disposal Target Area

The disposal zone (and target area) is a circle with a 1500′ radius centered at Latitude N 48 degrees 30.88′ and Longitude W 123 degrees 43.48′. This area will be specified in all permits issued for disposal at this site.

The 1500′ radius is believed to be adequate for average conditions at the site. A barge travelling at 2 knots (3.4 ft/sec) relative to the water and, with a 1 knot current, travelling 3 knots relative to the bottom (5.06 ft/sec) would cross a 3000′ diameter circle in 10 minutes. This is adequate time to empty a barge. In some cases, wind or current conditions at the site could require adjustments to stay within the 3000′ circle or delaying disposal if conditions are extreme.

5.4 Navigation Controls

The official positioning aid for the Rosario Strait disposal site is the Coast Guard Vessel Traffic Service (VTS). All site users must contact the VTS and obtain positioning confirmation before initiating disposal. However, Loran-C coordinates will be provided to aid operators in positioning.

5.5 Debris Control

Pre-dredging testing of dredged material shall include an assessment of floatable and non-floatable debris hazards (defined as hazards to navigation or other significant beneficial uses) likely to result from dredging. The assessment may be based on the following types of information:

a) Interviews with dock owners and users familiar with types of cargo handled that could have spilled in the dredging area.

b) Test dredging to confirm presence of log debris.

c) Side-scan sonar of dredge area to confirm presence and aerial extent of log debris.

d) Diver observations of dredging area.

e) Review of previous dredging records in the area which may be representative of types and relative amounts of log debris encountered.

If the site assessment indicates the presence of log debris or other

debris hazards, the contractor's dredging plan shall include methods of separating debris before open-water disposal. Screening may be accomplished by a clamshell dredge operator retrieving debris from the barge hopper. If this can not be done effectively, the contractor shall propose other methods, such as passing material through a steel grid (e.g., 24" x 24" mesh). The contractor shall maintain a daily record of debris encountered. The daily record should describe the operator's name, size, type, and method of disposal.

5.6 <u>Site Use Reporting</u>

Disposal site users will be required to complete the DNR Site Use Log (Figure 1) for each use of the disposal site. Copies of the site use records shall be submitted to DNR at least once per month. Copies of the records shall also be retained on the tug for one month.

5.7 <u>Compliance Inspection</u>

Only dredged material meeting the PSDDA guidelines may be disposed of at the site. Compliance will be ensured through pre-dredging testing of dredged material and through inspection of dredging operations.

Dredging site inspection plans for non-Corps projects will be prepared by Ecology. The plans will define inspection necessary to assure the quality of material sent to open-water disposal and compliance with the contractors' approved plan for debris removal. Ecology and the Corps will coordinate inspections for compliance by non-Corps projects and the Corps will inspect its own contractors. Copies of all Ecology and Corps dredging site inspection plans will be forwarded to DNR before dredging begins.

Prior to permit issuance, dredgers will be required to submit disposal site use plans covering positioning, debris handling, timing and other site use factors. DNR and the Corps will periodically inspect non-Corps projects for compliance with these plans (as modified by permit conditions).

The Corps will inspect disposal site positioning and debris removal for Corps projects and keep disposal site use records similar to those kept by dredgers for non-Corps projects. Copies of these records and of Corps inspection reports will be periodically sent to DNR.

Disposal site positioning accuracy will be verified for each use by VTS. Site users will be required to contact the Coast Guard before disposal to confirm positioning and to report the tug, barge, and skipper's names, DNR permit number, and the time dumping begins. Site users must also report the time disposal ends. The Coast Guard will contact any vessels which appear to be making improper use of the site. This could include improper timing, lack of permits, use of improper equipment, or inaccurate positioning. If improper use is discovered, the Coast Guard will:

a. Tell the operator why and advise them to stop;

b. Record the type of improper use and ask the source and yardage of

material and name of project employer (if disposal has already occurred); and

c. Notify DNR immediately or on the next working day.

The Coast Guard will maintain a record of all contacts with vessels using the disposal site. A copy of the record will be sent to DNR weekly. DNR will provide the Coast Guard with the following:

a. A statement of any site use restrictions for which violations could be identified through VTS;

b. Names and permit numbers of all tugs and barges authorized to use the site; and

c. Work and off-hours phone numbers for emergency contacts in case a violation is discovered in-progress and advice is needed.

5.8 Site Use Restrictions

There are no blanket restrictions on disposal site use for noise or navigation impacts at the Rosario Strait disposal site. However, individual permits may be conditioned for these or other factors.

5.9 Environmental Monitoring

The Rosario Strait site is located in the most energetic area of all disposal sites. The water depth is 230' at the center of the disposal zone. Due to strong currents in the area, dredged material is expected to be moved off the site within a few days. Therefore, physical monitoring will be conducted to verify the absence of mounds on the bottom but no biological or chemical monitoring will be performed. Table 2 summarizes the estimated fifteen year monitoring schedule.

Revised 8/15/89
PII.1

EXHIBIT D

ENVIRONMENTAL MONITORING PLAN
FOR UNCONFINED, OPEN-WATER, DREDGED MATERIAL DISPOSAL SITES

PHASE II AREA - NORTH AND SOUTH PUGET SOUND

This Environmental Monitoring Plan was prepared with participation from all Work Groups of the Puget Sound Dredged Disposal Analysis. Significant contributions were made by the following staff:

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Keith Phillips, Washington Department of Ecology

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Eric Nelson, Seattle District, U.S. Army Corps of Engineers

August, 1989

ABSTRACT

This document presents an environmental monitoring plan for the Puget Sound Dredged Disposal Analysis (PSDDA) Phase II unconfined, open-water disposal sites for dredged material disposal. The Phase II sites include two nondispersive sites (Bellingham Bay and Anderson/Ketron Islands in South Puget Sound) as well as three dispersive sites (Rosario Straits, near Port Townsend and near Port Angeles). The monitoring plan for nondispersive sites is designed to verify that no unacceptable adverse effects have occurred within or beyond the disposal site and to assure that dredged material disposed at the sites remains within the disposal site boundary. Dispersive sites will only be monitored to establish that material does not build up after disposal.

Three types of monitoring efforts are described for nondispersive sites, including a baseline survey of the sites to establish conditions prior to initiation of disposal activity, as well as partial and full monitoring efforts which will be conducted following opening of the sites. Full monitoring is an intensive field evaluation of conditions within and beyond each disposal site boundary, while partial monitoring involves a less intensive monitoring effort. Partial monitoring will occur when disposal activity at the disposal sites is not great enough to warrant a full evaluation of area conditions. Partial monitoring will be sufficient to establish if unexpected conditions are developing due to dredged material disposal.

Parameters measured during nondispersive monitoring include disposal site physical characteristics, chemical and biological analysis of the dredged material present on site, chemical reconnaissance outside the disposal site boundary, and determination of benthic abundance and bioaccumulation in benthic species located down-current from the disposal sites. Disposal sites' physical characteristics will establish the limits of dredged material has spread, while the other parameters are intended to determine the chemical toxicological properties of the material disposed at the open-water sites, and assure that dredged material is not impacting resources outside the disposal site boundary. Physical monitoring only will be done at dispersive sites.

In addition to presenting a general monitoring plan for the two Phase II nondispersive sites, site-specific plans are presented. Site-specific adaptations are needed because of special considerations associated with the proximity of other contaminant sources to the disposal sites and/or location of down current resources. Site-specific monitoring plans for the three dispersive sites are also presented.

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1. INTRODUCTION

The Puget Sound Dredged Disposal Analysis (PSDDA) is a four and one-half year study of dredged material disposal in Puget Sound initiated in April 198⁻. The study is being conducted jointly by the Corps of Engineers (Seattle District), Environmental Protection Agency (EPA), and the Washington Departments of Natural Resources and Ecology. PSDDA is being conducted in two phases (each about three and one-half years in length): Phase I covers central Puget Sound and Phase II (initiated in April 1986) covers south and north Puget Sound.

The objectives of PSDDA are to locate sites in Puget Sound for unconfined, open-water disposal of dredged material, define evaluation procedures for determining when dredged material is acceptable for discharge at these sites, and prepare site management plans (including permit and monitoring requirements). Responsibility for accomplishing these three objectives was assigned to three interagency work groups (Disposal Site Work Groups (DSWG), Evaluation Procedures Work Group (EPWG), and Management Plan Work Group (MPWG)), who work under the direction of the PSDDA Study Director. This Exhibit describes the environmental monitoring plan for the Phase II study area (north and south Puget Sound).

All work groups contributed to the development of the Phase II monitoring plan. DSWG and EPWG determined the environmental monitoring requirements, with DSWG focusing on requirements for evaluating physical placement and effects, and EPWG placing emphasis on requirements for evaluating chemical effects of dredged material disposal. MPWG addressed plan funding and implementation.

This document describes the environmental monitoring plan (including baseline conditions that must be established prior to initiation of disposal activity) for the PSDDA Phase II preferred disposal sites. The monitoring plan is expected to be implemented in the spring of 1989 when baseline studies would be accomplished. This would allow the new Phase II sites to be available during the fall of 1989.

The primary functions of the monitoring plan are to ensure compliance with the Section 404(b)(1) guidelines and to field verify the PSDDA predictions of site conditions following disposal. Moreover, monitoring will provide the data to allow direct response to agency and public concerns regarding site conditions and environmental impacts. Finally, environmental monitoring data forms the basis for the annual review of the need for changes in the evaluation procedures.

The monitoring plan presented in this report covers both nondispersive sites and dispersive sites. For nondispersive sites a five-step process is set forth as was done for Phase I, taking into account disposal site characteristics and the dredged material that will be allowed for disposal at these unconfined open-water sites (see Sections 2 through 6). Development of the process proceeded from a general consideration of potential impacts of dredged material disposal at the nondispersive sites to detailing of

site-specific monitoring programs and data interpretation guidelines. An estimate of costs of conducting baseline studies and monitoring is contained in Section 9. Steps taken in developing the plan were:

1. Identification of concerns that warrant monitoring (Section 2).

2. Development of testable hypotheses to address monitoring concerns (Section 3).

3. Design of a general monitoring program (types of data to be collected, tools used to collect data, frequency of collections, etc.) which will gather sufficient data to test the hypotheses (Section 4).

4. Definition of site-specific monitoring requirements to address the effects of concern identified in Step 1 (Section 5).

5. Development of a site management strategy and data interpretation guidelines (Section 6).

At the dispersive sites the monitoring plan is considerably less complex as only verification of dispersion is needed. Because no monitoring for chemical induced biological effects will occur, the dredged material released at these sites will be required to pass disposal guidelines more restrictive than allowed for the *nondispersive* sites (see Chapter 5 of MPR). Baseline surveys and monitoring approximately every five years for disposal mound formation are part of the Phase II monitoring plan (see Section 7).

As new information is developed during the PSDDA monitoring program, the Puget Sound Water Quality Authority ambient monitoring program, and other studies, both here and in other parts of the country, elements of the monitoring program may be changed to reflect the most appropriate technique.

2. IDENTIFICATION OF CONCERNS THAT WARRANT MONITORING - NONDISPERSIVE SITES

The quality of dredged material that will be acceptable for disposal at the preferred PSDDA open-water nondispersive sites influences monitoring requirements. "Site condition II" has been selected as the preferred biological effects condition for site management at the unconfined, PSDDA Phase I Management Plan Report (MPR) and Final Environmental Impact Statement (FEIS). By definition, Site Condition II could result in "minor adverse effects, due to chemicals of concern in dredged material, on biological resources" at the disposal site (EPTA, 1988). Minor effects are defined as potential chronic sublethal effects, but no significant acute toxicity within the site, or its dilution zone. Because only acceptable sediments will be discharged at the disposal sites, the aggregate condition of each site is expected to be substantially better than allowed under the proposed management condition.

For details on the monitoring concerns, please review Exhibit I of the Phase I MPTA.

3. DEVELOPMENT OF TESTABLE HYPOTHESES TO ADDRESS MONITORING QUESTIONS - NONDISPERSIVE SITES

Please refer to Exhibit I of the Phase I MPTA (1988).

4. GENERAL MONITORING PLAN - NONDISPERSIVE SITES

Please refer to corrected Exhibit I MPTA (1988).

5. SITE SPECIFIC MONITORING PLANS - NONDISPERSIVE SITES

The general monitoring plan is adapted to each of the Phase II sites based on physical and biological conditions at the site, anticipated annual loading, and proximity of potential contaminant sources to the disposal site. The combined sampling and analysis plan for nondispersive as well as dispersive sites are shown in Tables 3-8.

5.1 Bellingham Bay Disposal Site (Figures 2 a-c)

The Bellingham Bay site is in a relatively flat, nondispersive area with water depth of 96 feet with weak northwest to southeast currents (DSS TA, 1988).

The benchmark station nearest Bellingham represents a monitor of the urban environment. Another benchmark station lies south of the site and is situated so as to represent natural conditions in greater Bellingham Bay. The third lies between the site and near shore urban activities. In all cases, each off-site benchmark chemistry station is paired with an off-site benchmark biological station.

Four gradient lines were sampled during baseline. Bottom currents are such that a dominant direction cannot be determined prior to disposal. The SVPS photos and bioaccumulation samples were analyzed. The benthic abundance samples from the gradient that most likely represent the current direction were analyzed and the rest of the benthic data were archived (see Table 1). Chemical samples were taken from one station on-site and four stations around the perimeter (Figure 1).

Partial event monitoring includes one on-site chemistry station and four perimeter stations. In addition, sediment from the three benchmark chemistry stations will be collected, bioassays conducted, but sediment for chemistry analysis will be archived.

Sampling during full monitoring will include collection of sediment and biological organisms from all stations as outlined in the general description of full monitoring (see Exhibit 1 of Phase I MPTA (i988)).

Analysis will be conducted on all samples collected except for those collected from the benchmark chemistry and biology stations. These samples were archived.

Crab tissue from the site will be obtained prior to site use to allow monitoring of bioaccumulation during full monitoring.

5.2 Anderson/Ketron Islands Disposal Site (Figure 3 a-c)

The Anderson/Ketron Islands disposal site is in a relatively flat nondispersive area with currents that are moderate and tend to flow north to south at depth (DSS TA, 1988). The average depth at the site is about 420 feet.

Only one benchmark station will be established at the site based on baseline information. Its purpose is to represent natural conditions in the area. Four benchmark stations were sampled during baseline. Using SVPS data to find comparable sediment grainsize relative to the disposal site.

Two gradient lines were sampled during baseline. Bottom current data from the disposal siting studies indicate that the dominant bottom current is to the south. However, a northerly gradient was included in case physical measurements during partial or full monitoring shows material is moving in a northerly direction. Both gradients were analyzed for SVPS and bioaccumulation (see Table 2). The benthic abundance samples were analyzed from the gradient along with the dominant current direction. The other will be archived. Chemical samples were taken from one station on-site and four stations around the perimeter (Figure 1).

Partial event monitoring includes one on-site chemistry station and four perimeter stations. In addition, sediment from the benchmark chemistry station will be collected, bioassays conducted, but sediment for chemistry analysis will be archived.

Sampling during full monitoring will include collection of sediment and biological organisms from all stations as outlined in the general description of full monitoring (see Exhibit I of Phase I MPTA (1988)0. Analysis will be conducted on all samples except for those collected from the benchmark chemistry and biology stations. These samples will be archived.

6. DATA INTERPRETATION AND DECISIONS ON SITE MANAGEMENT - NONDISPERSIVE SITES

Please refer to corrected Exhibit I MPTA (1988).

7. IDENTIFICATION OF CONCERNS THAT WARRANT MONITORING - DISPERSIVE SITES

Dispersive sites are located in areas of high bottom currents where dredged material placed at the site is expected to be dispersed. Therefore, the only parameter that can be measured at the sites is the physical situation on site The monitoring question therefore is whether

material placed at the dispersive sites remains on site or disperses. Each dispersive site will be monitored using precision vertical soundings so as to detect mounding of dredged material on the bottom within the target parameter.

8. SITE SPECIFIC MONITORING PLAN AND DATA INTERPRETATION - DISPERSIVE SITES

8.1 Rosario Strait (Figure 6)

The Rosario Strait site is located two nautical miles south of Reef Point on Cypress Island in 230 feet of water.

During baseline, vertical soundings over continuous transects will be made at the site at 100 meter spacing. The transects will begin and end 100 meters outside the perimeter of the disposal site. The information will be maintained at the Corps of Engineers. During monitoring, the same transects will be rerun using the same type or quality of equipment as used in baseline. The Corps of Engineers will compare the baseline profiles to the monitoring profiles to determine if a significant change has occurred.

8.2 Port Angeles (Figure 4)

The Port Angeles site is located approximately four and one-half nautical miles north of Port Angeles in 435 feet of water.

During baseline, vertical soundings over continuous transects will be made at the site at 100 meter spacing. The transects will begin and end 100 meters outside the perimeter of the disposal site. The information will be maintained at the Corps of Engineers. During monitoring, the same transects will be rerun using the same type or quality of equipment as used in baseline. The Corps of Engineers will compare the baseline profiles to the monitoring profiles to determine if a significant change has occurred.

8.3 Port Townsend (Figure 5)

The Port Townsend site is located ten and one-half nautical miles northwest of Port Townsend is 360 feet of water.

During baseline, vertical soundings over continuous transects will be made at the site at 100 meter spacing. The transects will begin and end 100 meters outside the perimeter of the disposal site. The information will be maintained at the Corps of Engineers. During monitoring, the same transects will be rerun using the same type or quality of equipment as used in baseline. The Corps of Engineers will compare the baseline profiles to the monitoring profiles to determine if a significant change has occurred.

9. ESTIMATED MONITORING SCHEDULE AND COSTS

A proposed 15-year monitoring schedule is summarized in Table 9. This schedule assumes there will be sufficient use at both nondispersive and at least one dispersive disposal site in the first five years to require full monitoring at each site within that period. Disposal activity forecasted for

the Bellingham Bay site indicates that a sufficient volume of material will be disposed in the first year of site use to warrant full monitoring. Disposal activity at the other nondispersive site is forecasted to be low enough that full monitoring would not be required until, probably, the fifth year of site use. However, actual disposal volumes may vary significantly from projections.

If volumes are too low to warrant cost-effective monitoring, initial monitoring may be delayed. Decisions on monitoring will be made by the Department of Natural Resources and the Corps of Engineers, in consultation with EPA and Ecology, based on actual site use. Based on a recent review of modeling and verification data, it appears that measurable levels of material may not be present on site until after 200,000 c.y. have been placed at nondispersive sites. However, to be conservative the PSDDA agencies will consider monitoring actions after at least 100,000 c.y. have been placed at the site. Verification of the appropriate trigger volume will occur during monitoring of high volume disposal sites in the Phase I area.

The monitoring schedule for the nondispersive sites also assumes that no evidence of impacts are found due to dredged material off-site and that chemical concentrations and toxicity on-site or within the dilution zone do not exceed guideline levels. If any of these conditions exist after the first five years of monitoring (following at last one full monitoring effort at each site) then the monitoring schedule might have to be altered.

Estimates for the costs of the proposed PSDDA monitoring plan are based on 1988 price levels for sampling, analysis, boat time, and monitoring program administration. The state costs of monitoring for each disposal site are presented in Table 10. These estimates include 20 percent agency overhead and management, and 15 percent contingency. Inflation was not considered in the calculation of costs. Costs are projected over a plan horizon of 15 years following the monitoring effort sequence presented in Table 9. The costs presented in Table 10 include costs of conducted Steps 1 and 2 in the site management process. However, they <u>do not</u> include funds for conducting extensive site surveys if unacceptable impacts due to dredged material disposal are found (i.e., Step 3 in the site management process). The potential need for funding extensive site investigations will be evaluated when at least one full monitoring effort has been conducted at each site. Federal costs are presented in Table 11.

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TABLE 1

SUMMARY OF ANALYTICAL REQUIREMENTS
PROPOSED TO BE UNDERTAKEN AT THE BELLINGHAM BAY SITE

	Baseline	Partial	Full Study
On-site Chemistry	1	1	3
On-site Bioassays	1	1	3
Perimeter Chemistry	4	4	12
Benchmark Chemistry	3	3 2/	3 2/
Benchmark Bioassays	3	3	3
Benthos Abundance	15 1/	0	15
Benthos Body Burden	24	0	6
Benchmark Benthos Abundance	15	0	15 2/
Benchmark Benthos Body Burden	6	0	6 2/
SVPS 3/	67	54	71

1/The number of stations sampled during the baseline will be greater than shown (see Figure 6a), but only those stations from the gradient that is along the primary direction of movement will be analyzed. The other gradients will be archived.
2/Samples will be archived and analyzed only if results of on-site, perimeter, or gradient monitoring station data require testing of benchmark station samples.
3/Includes 20 percent replication of selected SVPS physical monitoring stations and three SVPS stations at each benchmark site.

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TABLE 2

SUMMARY OF ANALYTICAL REQUIREMENTS
PROPOSED TO BE UNDERTAKEN AT THE ANDERSON/KETRON ISLAND SITE

	Baseline	Partial	Full Study
On-site Chemistry	1	1	3
On-site Bioassays	1	1	3
Perimeter Chemistry	4	4	12
Benchmark Chemistry	1	1 2/	1 2/
Benchmark Bioassays	1	1	1
Benthos Abundance	15 1/	0	15
Benthos Body Burden	12	0	6
Benchmark Benthos Abundance	5	0	5 2/
Benchmark Benthos Body Burden	2	0	2 2/
SVPS 3/	50	54	65

1/The number of stations sampled during the baseline will be greater than shown (see Figure), but only those stations from the gradient that is along the primary direction of movement will be analyzed. The other gradients will be archived.
2/Samples will be archived and analyzed only if results of on-site, perimeter, or gradient monitoring station data require testing of benchmark station samples.
3/Includes 20 percent replication of selected SVPS physical monitoring stations and three stations at each benchmark site.

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TABLE 3. SAMPLING REQUIREMENTS FOR BASELINE

Monitoring Parameter	Disposal Site: Bellingham Bay	Anderson/Ketron Island	Dispersive(7)	Total
Dredged Material Stability				
SVPS 2/	67	50	0	117
Sonar transects	0	0	66	66
On-site Sediment Conditions				
On-site Chemistry and Bioassay 3/	6	6	0	12
Perimeter Chemistry 4/	24	24	0	48
Off-site Biological Condition				
Benthic Abundance 5/	60 (45)1/	30 (15)1/	0	90 (60)1/
Benthic Body Burden 6/	24	12	0	36
Benchmark Stations				
Chemistry Stations				
Chemistry and Bioassay 4/	18	6	0	24
Biological Stations				
Benthic Abundance 6/	15	5	0	20
Benthic Body Burden 7/	6	2	0	8

1/Numbers in parentheses are samples to be archived for future analysis.
2/Number of SVPS samples taken. The number of samples includes 20 percent replication of selected stations.
3/Minimum number of box core samples required. Each box core will be subsampled (upper 10 cm) to provide sufficient sediment for chemical analytical requirements and to conduct the three bioassays.
4/Minimum number of box core samples required. Each box core will be sampled (upper 2 to provide sufficient sediment for analytical requirements.
5/Minimum number of box core samples required. All samples will be sieved, fixed in preservative and stored until the first full monitoring effort. At that time, those samples taken from the selected gradient stations will be analyzed.
6/Minimum number of box core samples required (see Footnote 5.)
7/Vertical sonar transects will be made of each dispersive site at 100m intervals.

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TABLE 4. ANALYTICAL REQUIREMENTS FOR BASELINE

Monitoring Parameter	Disposal Site: Bellingham Bay	Disposal Site: Anderson/Ketron Island	Disposal Site: Dispersive(7)	Total
Dredged Material Stability				
SVPS	67	50 6/	0	117
Sonar transects	0	0	66	66
On-site Sediment Conditions				
On-site Chemistry 1/	1	1	0	2
On-site Bioassay 2/	1	1	0	2
Perimeter Chemistry 1/	4	4	0	8
Off-site Biological Condition				
Benthic Abundance 3/	15 5/	15 5/	0	30
Benthic Body Burden 4/	24	12	0	36
Benchmark Stations				
Chemical Stations				
Chemistry 1/	3	1	0	4
Bioassays 1/	3	1	0	4
Biological Stations				
Benthic Abundance 3/	15	5	0	20
Benthic Body Burden 4/	6	2	0	8

1/Each chemistry sample is composed of six subcomposites (each representing a single box core) from each station grid.
2/Sediment for each bioassay is a composite of six subcomposites (each representing a single box core) from each station grid.
3/Each box core will be analyzed separately. There are five replicates per stations.
4/Each station will be analyzed separately. There are two replicates per station.
5/One gradient will be analyzed during baseline, all others will be archived.
6/Four groups of SVPS stations (three replications each) will be used to locate a single benchmark station.
7/Vertical sonar transects will be made of each dispersive site at 100m intervals.

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TABLE 5. SAMPLING REQUIREMENTS FOR PARTIAL MONITORING

Monitoring Parameter	Disposal Site: Bellingham Bay	Disposal Site: Anderson/Ketron Island	Disposal Site: Dispersive(6)	Total
Dredged Material Stability				
SVPS 2/	54	54	0	108
Sonar transects	0	0	0	0
On-site Sediment Conditions				
On-site Chemistry and Bioassay 3/	6	6	0	12
Perimeter Chemistry 4/	24	24	0	48
Off-site Biological Condition				
Benthic Abundance	0	0	0	0
Benthic Body Burden	0	0	0	0
Benchmark Stations				
Chemical Stations				
Chemistry and Bioassay 5/	18 (18) 1/	6 (6) 1/	0	24 1/
Bilogical Stations				
Benthic Abundance	0	0	0	0
Benthic Body Burden	0	0	0	0

1/Numbers in parenthesis are samples to be archived for future analysis except for bioassays of fresh sediment.
2/Number of SVPS samples taken. The number of samples includes 20 percent replication of selected stations.
3/Minimum number of box core samples required. Each box core will be subsampled (upper 10 cm) to provide sufficient sediment for chemical analytical requirements and to conduct the three bioassays.
4/Minimum number of box core samples required. Each box core will be sampled (upper 2 cm) to provide sufficient sediment for analytical requirements.
5/Minimum number of box core samples required. Each box core will be subsampled (upper 2 cm) to provide sufficient sediment for chemical analytical requirements and to conduct bioassays. Bioassays for the reference stations will be conducted using fresh sediments. The sediment samples for chemistry will be archived (frozen for chemical analysis) until results of on-site chemistry are complete.
6/Vertical sonar transects will be made of each dispersive site at 100m intervals.

TABLE 6. ANALYTICAL REQUIREMENTS FOR PARTIAL MONITORING

Monitoring Parameter	Disposal Site: Bellingham Bay	Disposal Site: Anderson/Ketron Island	Disposal Site: Dispersive(3)	Total
Dredged Material Stability				
SVPS	54	54	0	108
Sonar transects	0	0	0	0
On-site Sediment Conditions				
On-site Chemistry 1/	1	1	0	2
On-site Bioassay 1/	1	1	0	2
Perimeter Chemistry 1/	4	4	0	8
Off-site Biological Condition				
Benthic Abundance	0	0	0	0
Benthic Body Burden	0	0	0	0
Benchmark Stations				
Chemical Stations				
Chemistry 1/	2 2/	1 2/	0	3 2/
Bioassay 1/	2	1	0	3
Biological Stations				
Benthic Abundance	0	0	0	0
Benthic Body Burden	0	0	0	0

1/Each chemistry and bioassay sample is composed of six subcomposites (each representing a single box core) from each station grid.
2/These samples will only be analyzed if changes are noted between monitoring and baseline data.
3/Vertical sonar transects will be made of each dispersive site at 100m intervals.

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TABLE 7. SAMPLING REQUIREMENTS FOR FULL MONITORING

Monitoring Parameter	Disposal Site: Bellingham Bay	Disposal Site: Anderson/Ketron Island	Disposal Site: Dispersive(9)	Total
Dredged Material Stability				
SVPS 2/	71	65	0	136
Sonar transects	0	0	66	66
On-site Sediment Conditions				
On-site Chemistry and Bioassay 3/	18	18	0	36
Perimeter Chemistry 4/	72	72	0	144
Off-site Biological Condition				
Benthic Abundance 5/	15	15	0	30
Benthic Body Burden 5/	6	6	0	12
Benchmark Stations				
Chemical Stations				
Chemistry and Bioassay 6/	18 (18) 1/	6 (6) 1/	0	24 (24) 1/
Biological Stations				
Benthic Abundance 7/	15 (15)	5 (5)	0	20 (20)
Benthic Body Burden 8/	4 (6)	2 (2)	0	8 (8)

1/Numbers in parentheses are to be archived for future analysis except bioassays of fresh sediment.
2/Number of SVPS samples taken. The number of samples includes 20 percent replication of selected stations.
3/Minimum number of box core samples required. Each box core will be subsampled (upper 10 cm) to provide sufficient sediment for chemical analytical requirements and to conduct the three bioassays.
4/Minimum number of box core samples required. Each box core will be subsampled (upper 2 cm) to provide sufficient sediment for analytical requirements.
5/Minimum number of box core samples required.
6/Minimum number of box core samples required. Each box core will be subsampled (upper 2 cm) to provide sufficient sediment for chemical analytical requirements and to conduct bioassays. Bioassays for the benchmark station will be conducted using fresh sediments. The sediment samples for chemistry will be archived (frozen for chemical analysis) until results of on-site chemistry are complete.
7/Minimum number of box core samples required. All samples will be sieved, fixed in preservative, and stored until the first full monitoring effort. At that time, those samples taken from the seleced gradient stations will be analyzed.
8/Minimum number of box core samples required. All tissue samples will be frozen until the first full monitoring effort. At that time, samples taken from the selected gradient stations will be analyzed.
9/Vertical sonar transects will be made of each dispersive site at 100m intervals.

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TABLE 8. ANALYTICAL REQUIREMENTS FOR FULL MONITORING

Monitoring Parameter	Disposal Site: Bellingham Bay	Anderson/Ketron Island	Dispersive(6)	Total
Dredged Material Stability				
SVPS	71	65	0	136
Sonar transects	0	0	66	66
On-site Sediment Conditions				
On-site Chemistry 1/	3	3	0	6
On-site Bioassay 2/	3	3	0	6
Perimeter Chemistry 1/	12	12	0	24
Off-site Biological Condition				
Benthic Abundance 3/	15	15	0	30
Benthic Body Burden 4/	6	6	0	12
Benchmark Stations				
Chemical Stations				
Chemistry 5/	3	1	0	4
Bioassay	3	1	0	4
Biological Stations				
Benthic Abundance 5/	15	5	0	20
Benthic Body Burden 5/	6	2	0	8

1/Each chemistry sample is composed of six subcomposites (each representing a single box core) from each station grid.
2/Sediment for each bioassay is a composite of six subcomposites (each representing a single box core) from each station grid.
3/Each box core will be analyzed separately. There are five replicates per station.
4/Each station will be analyzed separately. There are two replicates per station.
5/These samples will only be analyzed if changes are noted between monitoring and baseline data.
6/Vertical sonar transects will be made of each dispersive site at 100m intervals.

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TABLE 9

ANTICIPATED SCHEDULE FOR BASELINE STUDIES AND ENVIRONMENTAL MONITORING AT EACH DISPOSAL SITE OVER THE 15-YEAR MONITORING PERIOD[1]

	Phase II			Phase I		
FISCAL YEAR	Bellingham Bay	Anderson/ Ketron Is.	Dispersive Sites	Port Gardner	Elliott Bay	Commencement Bay
1988				B	B	B
1989	B	B	B			
1990					F	F
1991	F			F		
1992						
1993				F	F	F
1994			Ph			
1995	P				P	
1996						
1997		F				
1998				P		P
1999	F		Ph		P	
2000						
2001						
2002						
2003						
2004	P	P	Ph	P	P	P

B = Baseline Monitoring
F = Full Monitoring
P = Partial Monitoring
Ph = Physical Monitoring

[1]Monitoring efforts will only take place after the sites have been used and volumes are sufficient to reasonably expect that observable changes will be present. Dispersive sites (Port Angeles, Port Townsend, and Rosario Strait) will receive physical monitoring only. This table shows updated anticipated monitoring schedules for Phase I sites.

TABLE 10
ESTIMATE OF STATE COSTS FOR BASELINE AND MONITORING
OVER 15 YEARS FOR PHASE I AND II SITES

	Phase II			Phase I		
FISCAL YEAR	Bellingham Bay	Anderson/ Ketron Is.	Dispersive Sites[1]	Port Gardner	Elliott Bay	Commencement Bay
Baseline						
1988				$135,000	$110,000	$204,000
1989	$125,000	$ 98,000				
Monitoring						
1990				$145,000	$104,000	$147,000
1991	$142,000					
1992						
1993				$145,000	$104,000	$147,000
1994						
1995	$ 46,000				$ 46,000	
1996						
1997		$111,000				
1998				$ 46,000		$ 52,000
1999	$142,000				$ 46,000	
2000						
2001						
2002						
2003						
2004	$ 46,000	$ 40,000		$ 46,000	$ 46,000	$ 52,000
Total Monitoring	$376,000	$151,000		$382,000	$346,000	$398,000

[1]Dispersive site physical monitoring costs will be paid for by the Corps of Engineers.

TABLE 11

ESTIMATED FEDERAL COSTS FOR
PHYSICAL MONITORING

FISCAL YEAR	Bellingham Bay	Anderson/ Ketron Is.	Dispersive Sites	Total
1988				
1989			$ 25,000	$ 25,000
1990				
1991	$16,100			$ 16,100
1992				
1993				
1994			$ 25,000	$ 25,000
1995	$13,200			$ 13,200
1996				
1997		$15,100		$ 15,100
1998				
1999	$16,100		$ 25,000	$ 41,100
2000				
2001				
2002				
2003				
2004	$13,200	$13,200	$ 25,000	$ 51,400
Total	$58,600	$28,300	$100,000	$186,900

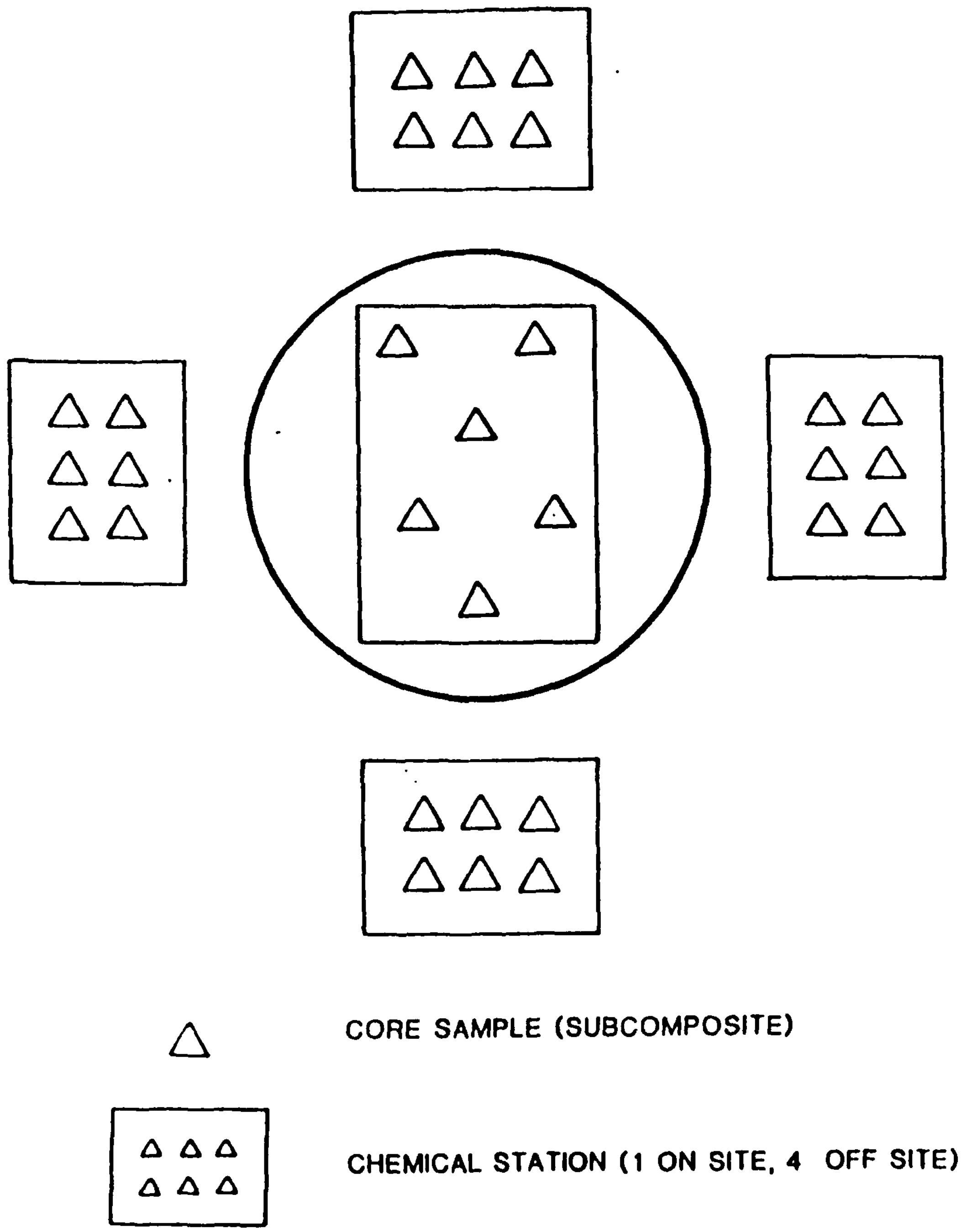
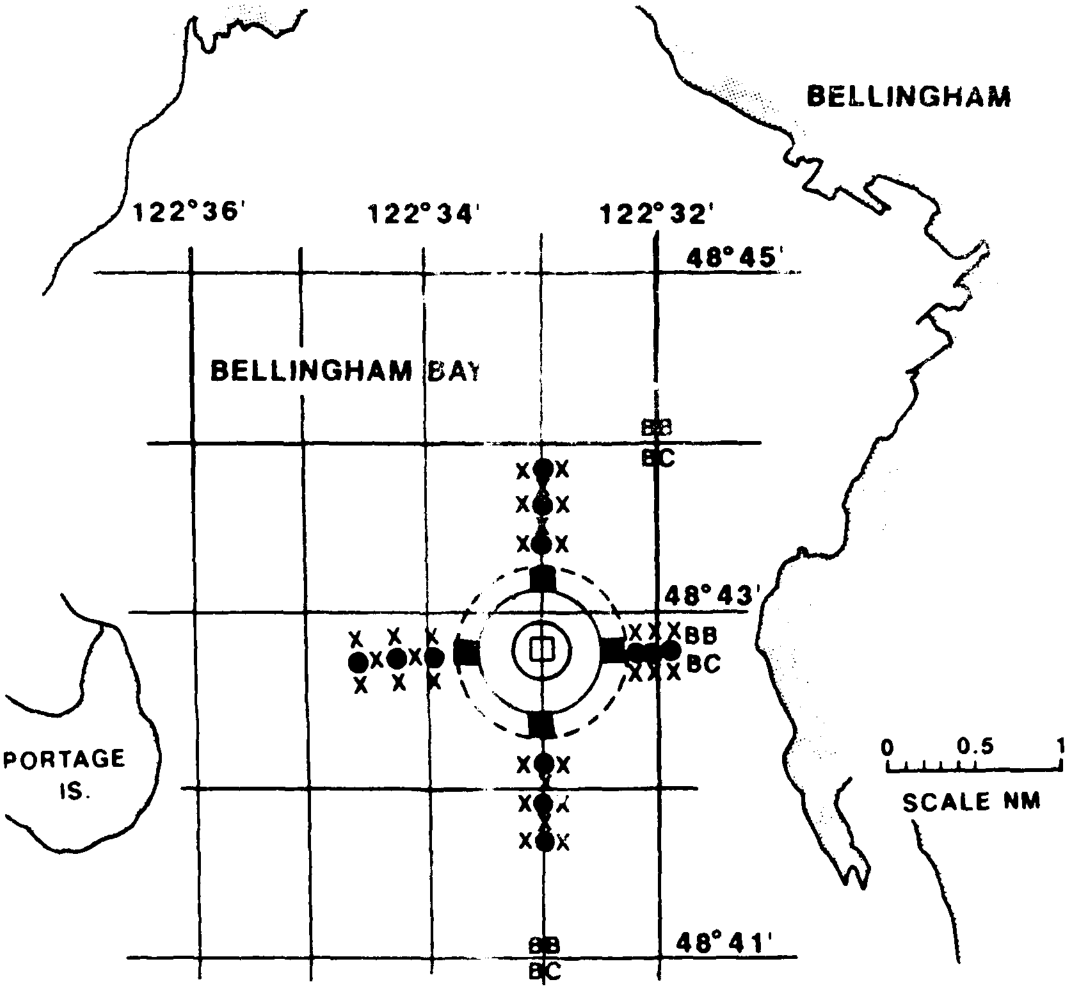


FIGURE 1. BASELINE CHEMICAL STATIONS FOR BELLINGHAM AND ANDERSON/KETRON ISLAND SITES

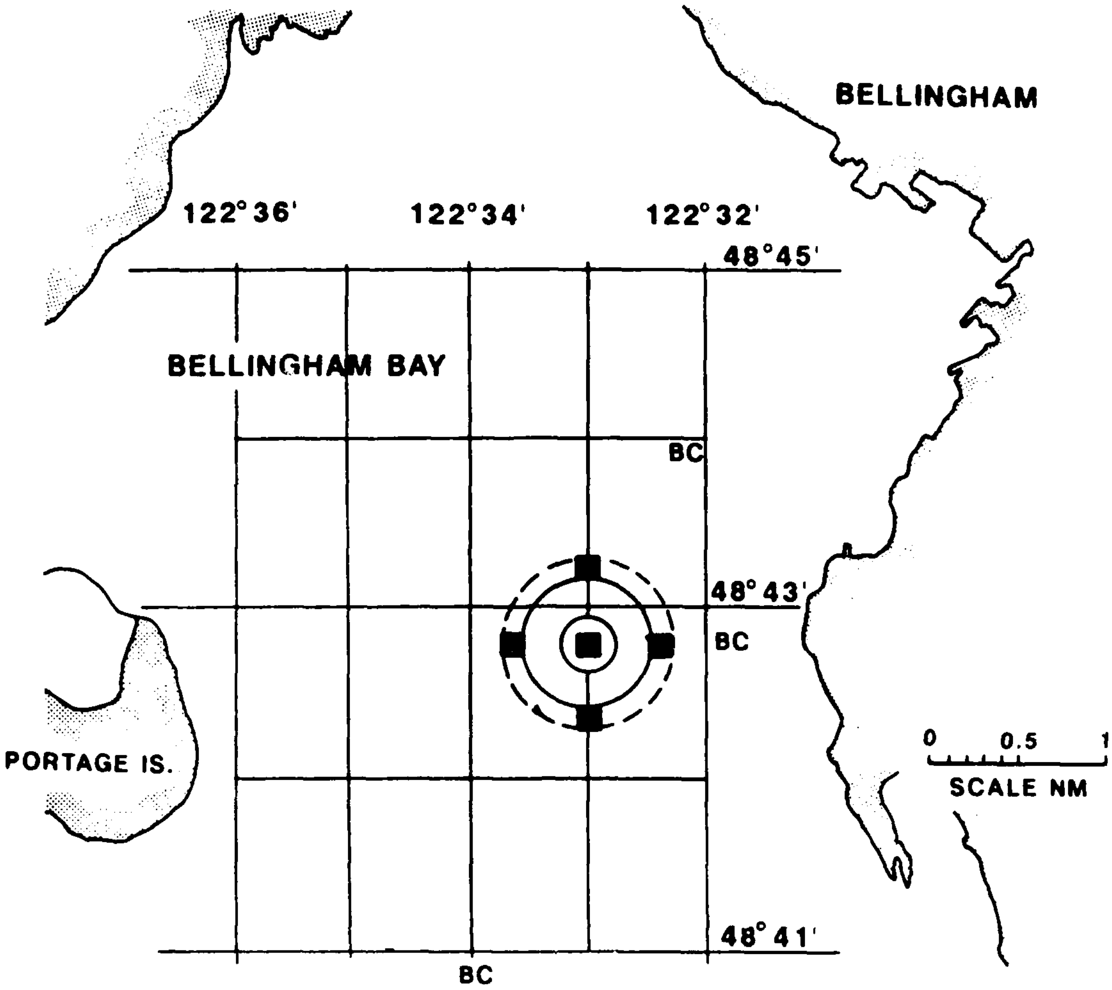


LEGEND

- DISPOSAL ZONE
- DISPOSAL SITE
- PERIMETER LINE
- CHEMICAL STATION
- BENTHIC BIOLOGICAL STATION
- BC BENCHMARK CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION
- X SVPS STATION ASSOCIATED WITH BIOLOGICAL STATION

(SVPS STATIONS FOR MAPPING THE DISPOSAL SITE MOUND AND FLANKS ARE ALSO CONDUCTED, BUT ARE NOT SHOWN)

FIGURE 2a BELLINGHAM BAY BASELINE SURVEY

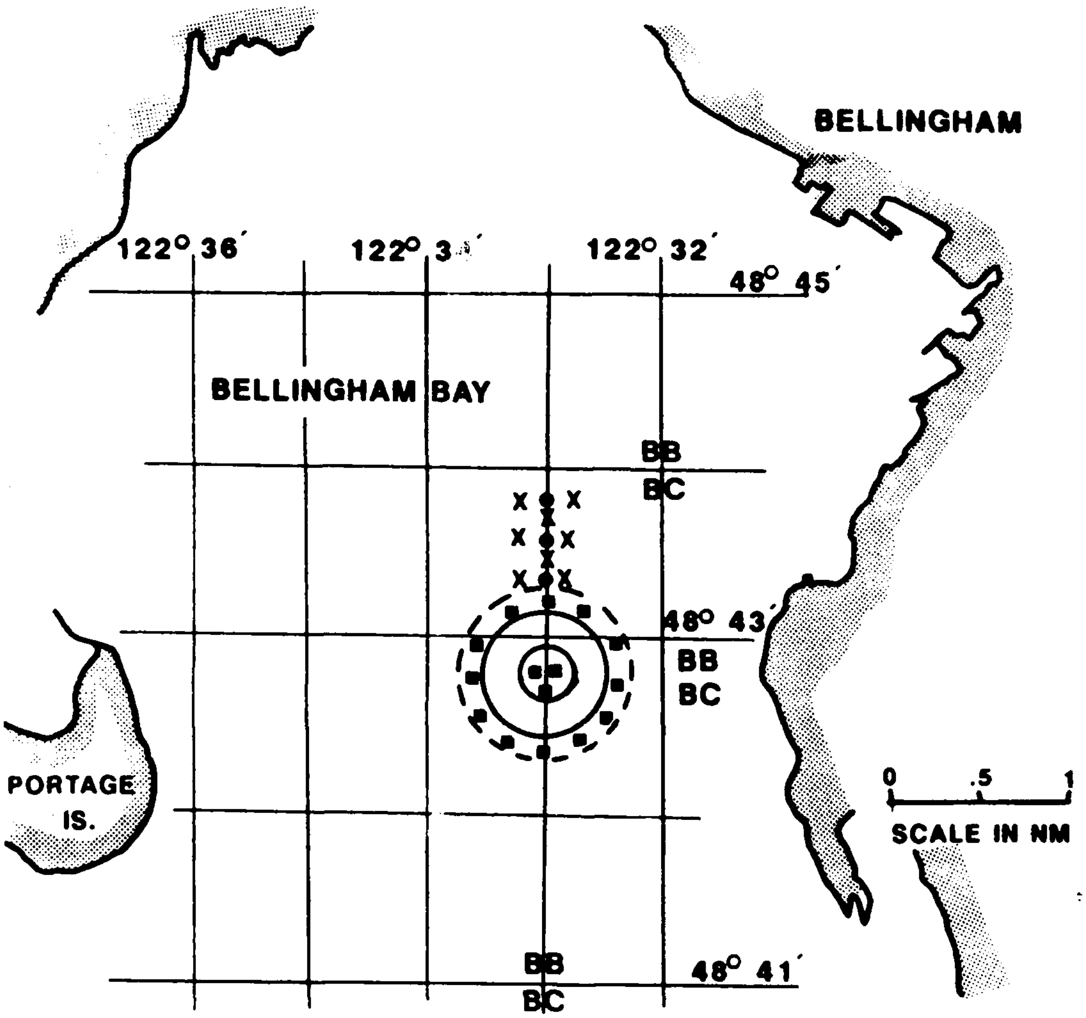


LEGEND

- ○ DISPOSAL ZONE
- ○ DISPOSAL SITE
- PERIMETER LINE
- ■ CHEMICAL STATION
- BC BENCHMARK CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION

(SVPS STATIONS FOR MAPPING THE DISPOSAL SITE MOUND AND FLANKS ARE ALSO CONDUCTED, BUT ARE NOT SHOWN)

FIGURE 2b BELLINGHAM BAY PARTIAL MONITORING

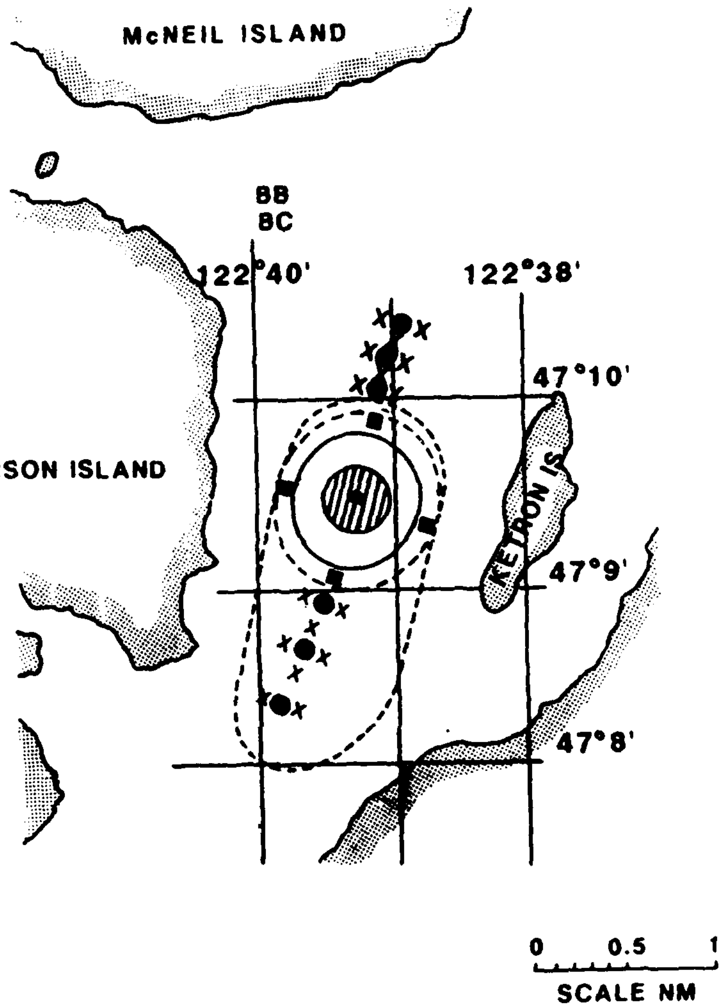


LEGEND

- ○ DISPOSAL ZONE
- ○ DISPOSAL SITE
- ◌ PERIMETER LINE
- ■ CHEMICAL STATION
- ● BENTHIC BIOLOGICAL STATION (POTENTIAL DIRECTION)
- BC BENCHMARK CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION
- X SVPS STATION ASSOCIATED WITH BIOLOGICAL STATION

(SVPS STATIONS FOR MAPPING THE DISPOSAL SITE MOUND AND FLANKS ARE ALSO CONDUCTED, BUT ARE NOT SHOWN)

FIGURE 2c BELLINGHAM BAY FULL MONITORING

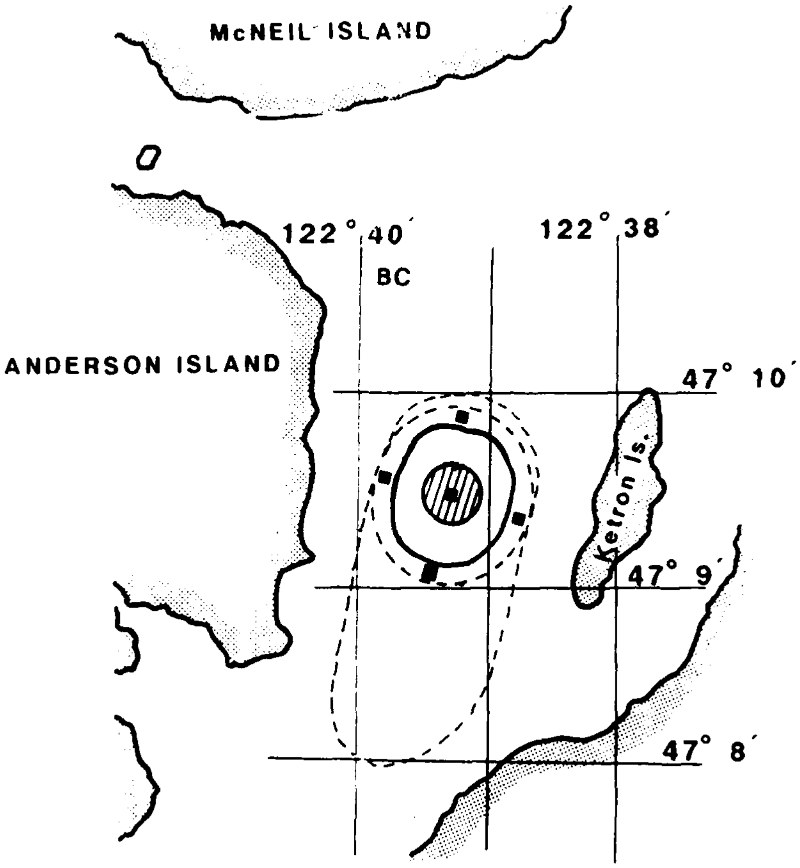


LEGEND

- ○ DISPOSAL ZONE
- ○ DISPOSAL SITE
- ◌ PERIMETER LINE
- ■ CHEMICAL STATION
- ● BENTHIC BIOLOGICAL STATION
- BC BENCHMARK CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION
- X SVPS STATION ASSOCIATED WITH BIOLOGICAL STATION

(SVPS STATIONS FOR MAPPING THE DISPOSAL SITE MOUND AND FLANKS ARE ALSO CONDUCTED, BUT ARE NOT SHOWN)

FIGURE 3a ANDERSON/KETRON ISLAND BASELINE SURVEY



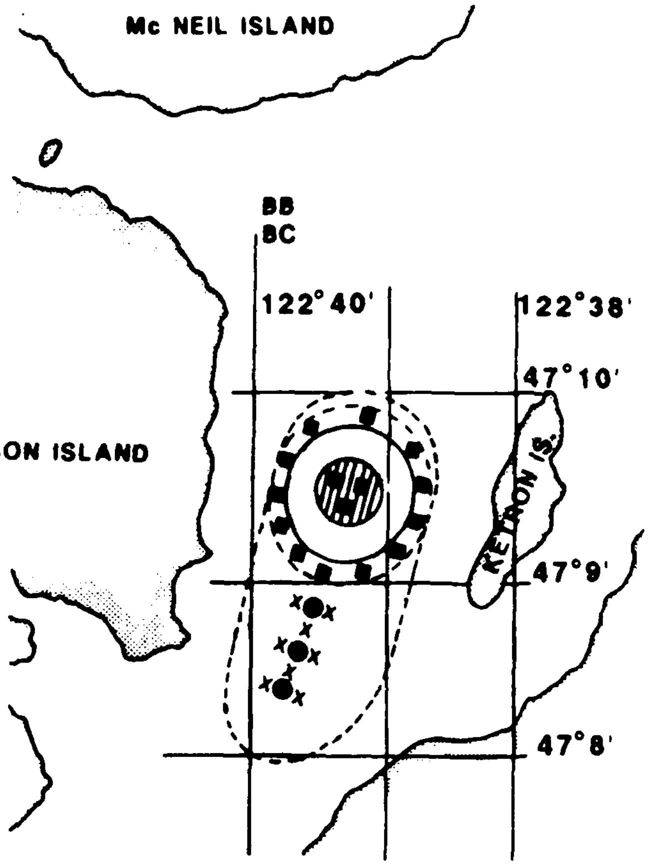
0 .5 1
SCALE NM

LEGEND

- DISPOSAL ZONE
- DISPOSAL SITE
- PERIMETER LINE
- ■ CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION
- BC BENCHMARK CHEMICAL STATION

(SVPS stations for mapping the disposal site mound and flanks are also conducted, but are not shown)

FIGURE 3b ANDERSON / KETRON ISLAND PARTIAL MONITORING



0 0.5 1
SCALE NM

LEGEND

- DISPOSAL ZONE
- DISPOSAL SITE
- PERIMETER LINE
- CHEMICAL STATION
- BENTHIC BIOLOGICAL STATION (POTENTIAL DIRECTION)
- BC BENCHMARK CHEMICAL STATION
- BB BENCHMARK BENTHIC BIOLOGICAL STATION
- X SVPS STATION ASSOCIATED WITH BIOLOGICAL STATION

(SVPS STATIONS FOR MAPPING THE DISPOSAL SITE MOUND AND FLANKS ARE ALSO CONDUCTED, BUT ARE NOT SHOWN)

FIGURE 3c ANDERSON/KETRON ISLAND FULL MONITORING

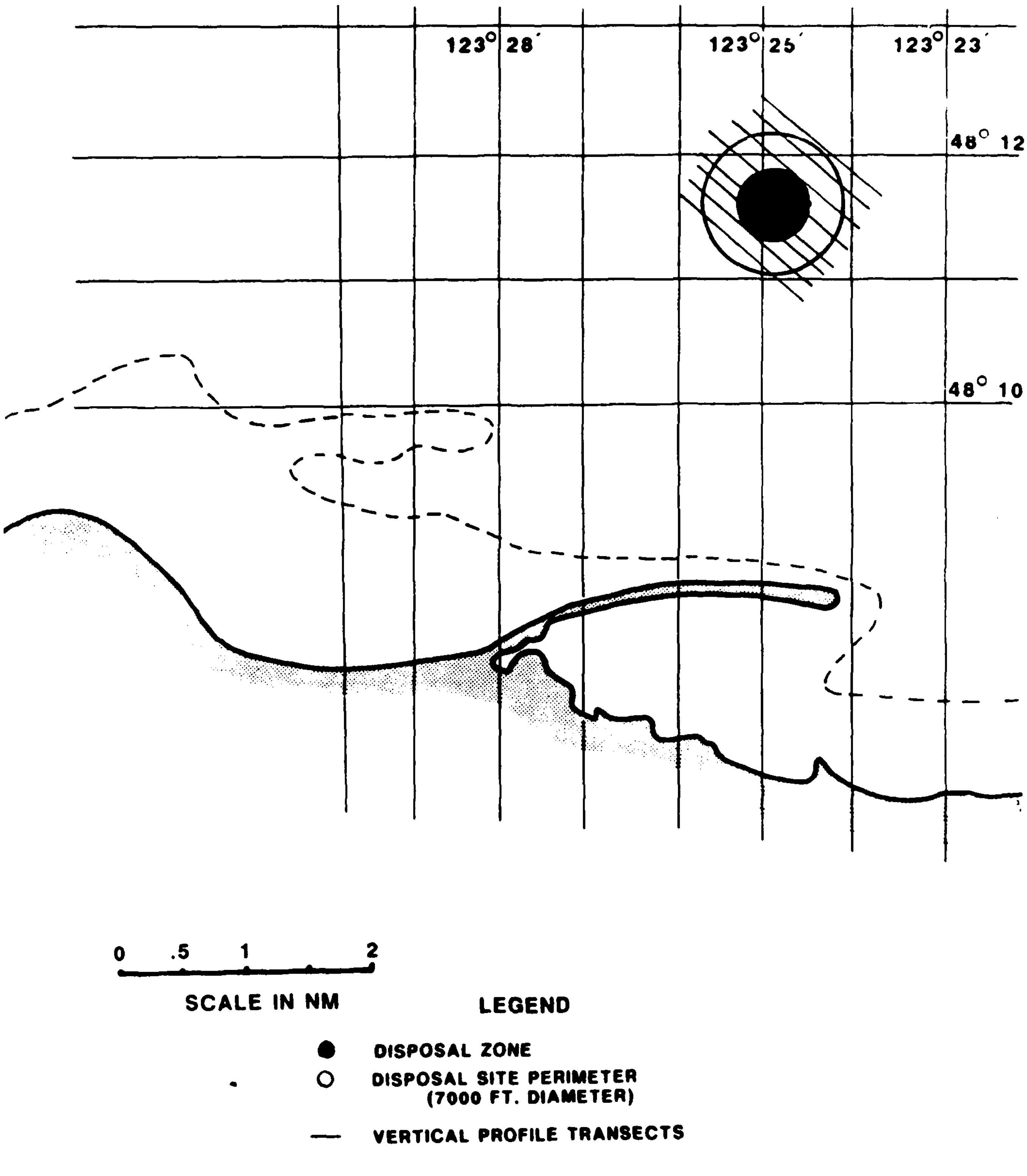


FIGURE 4 PORT ANGELES BASELINE SURVEY AND MONITORING

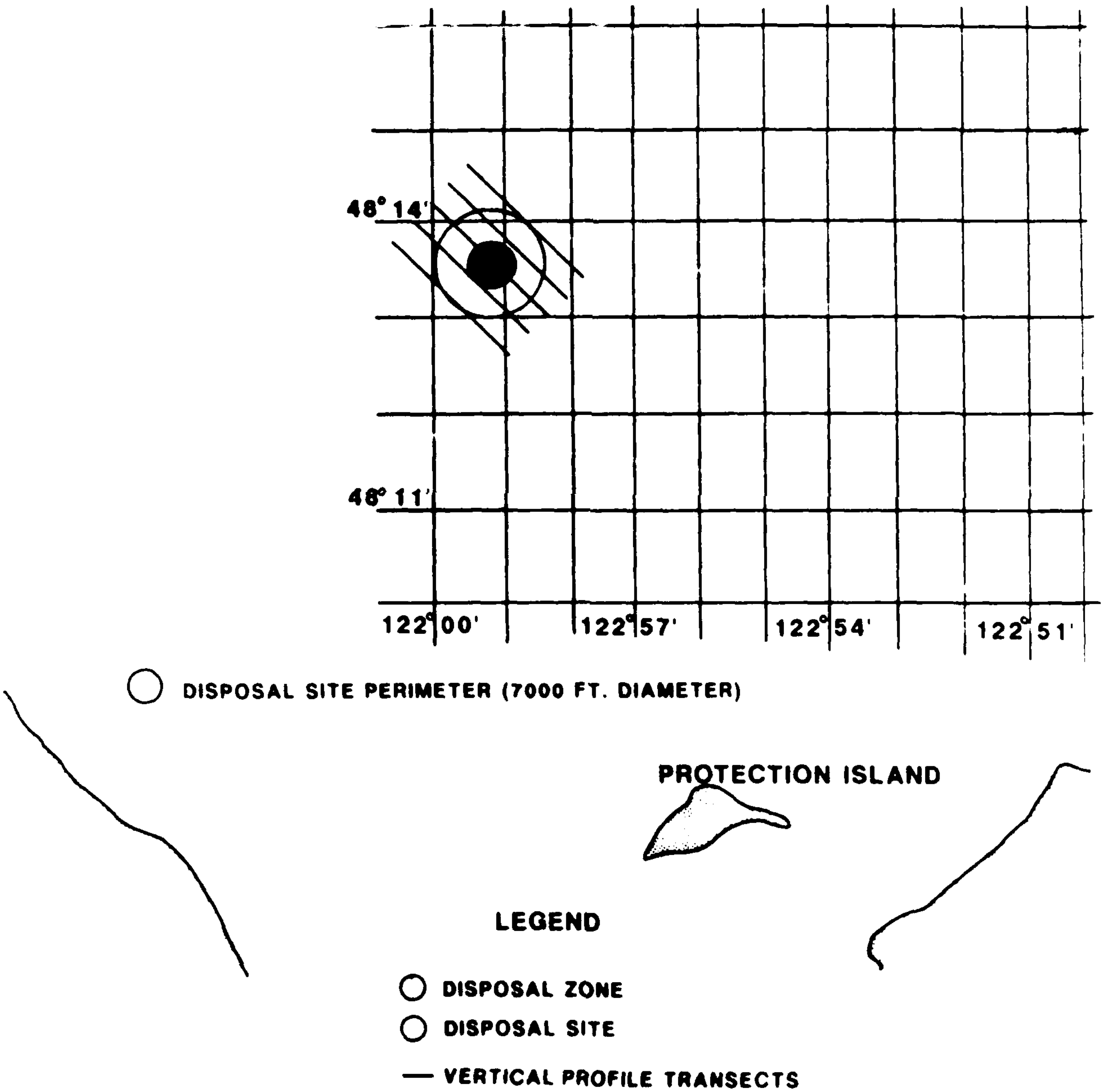


FIGURE 5 PORT TOWNSEND BASELINE SURVEY AND MONITORING

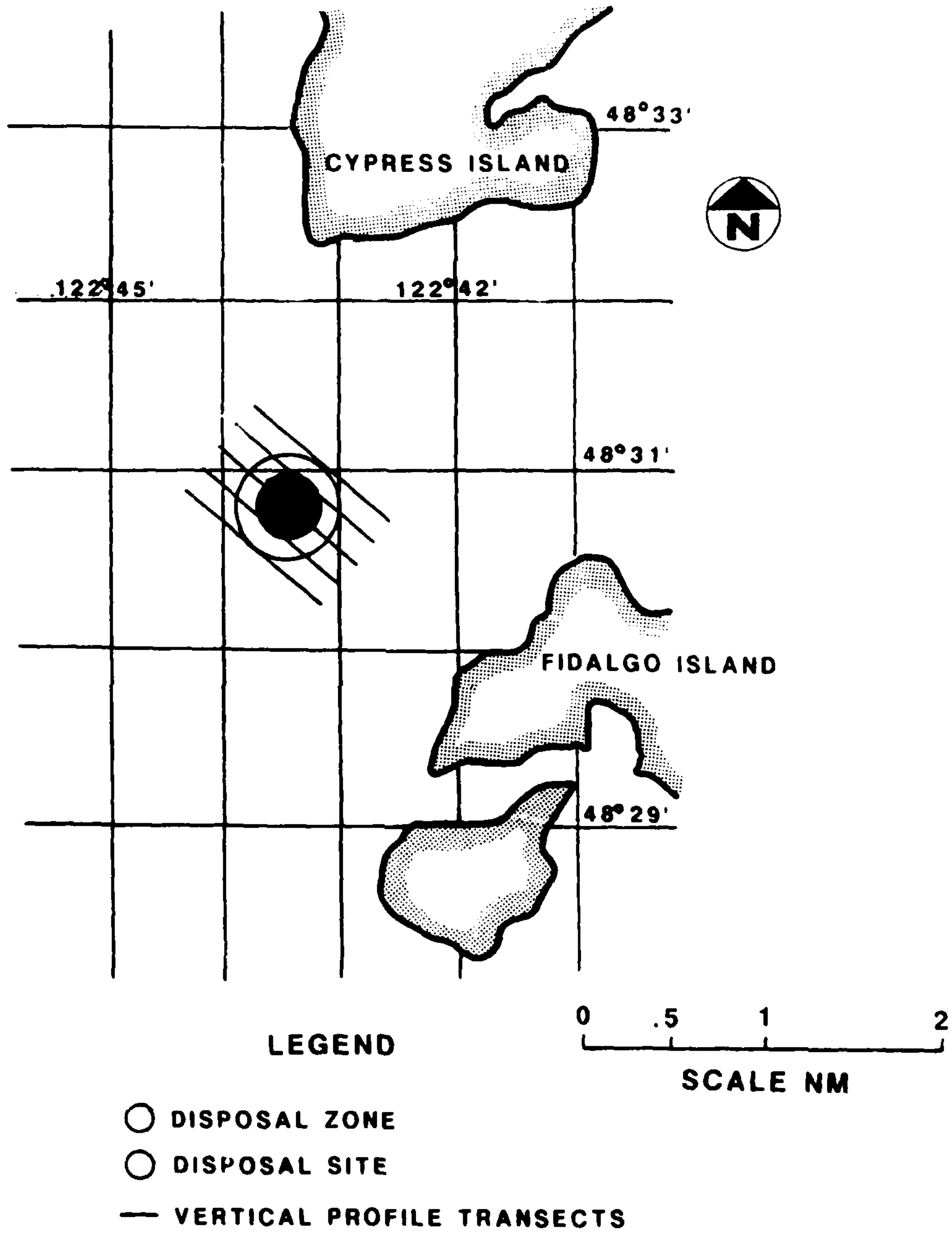


FIGURE 6 ROSARIO ST. BASELINE SURVEY AND MONITORING

GLOSSARY OF TERMS AND ABBREVIATIONS

PUGET SOUND DREDGED DISPOSAL ANALYSIS (PSDDA)
GLOSSARY OF TERMS

Amphipods. Small shrimp-like crustaceans (for example, sand fleas). Many live on the bottom, feed on algae and detritus, and serve as food for many marine species. Amphipods are used in laboratory bioassays to test the toxicity of sediments.

Apparent Effects Threshold. The sediment concentration of a contaminant above which statistically significant biological effects would always be expected.

Area Ranking. The designation of a dredging area relative to its potential for having sediment chemicals of concern. Rankings range from "low" potential to "high" potential, and are used to determine the intensity of dredged material evaluation and testing that might be required.

Baseline Study. A study designed to document existing environmental conditions at a given site. The results of a baseline study may be used to document temporal changes at a site or document background conditions for comparison with another site.

Bathymetry. Shape of the bottom of a water body expressed as the spatial pattern of water depths. Bathymetric maps are essentially topographic maps of the bottom of Puget Sound.

Benthic Organisms. Organisms that live in or on the bottom of a body of water.

Bioaccumulation. The accumulation of chemical compounds in the tissues of an organism. For example, certain chemicals in food eaten by a fish tend to accumulate in its liver and other tissues.

Bioassay. A laboratory test used to evaluate the toxicity of a material (commonly sediments or wastewater) by measuring behavioral, physiological, or lethal responses of organisms.

Biota. The animals and plants that live in a particular area or habitat.

Bottom-Dump Barge. A barge that disposes of dredged material by opening along a center seam or through doors in the bottom of the barge.

Bottomfish. Fish that live on or near the bottom of a body of water, for example, English sole.

Bulk Chemical Analyses. Chemical analyses performed on an entire sediment sample, without separating water from the solid material in a sample.

Capping. See confined aquatic disposal.

Carcinogenic. Capable of causing cancer.

Clamshell Dredging. Scooping of the bottom sediments using a mechanical clamshell bucket of varying size. Commonly used in over a wide variety of grain sizes and calm water, the sediment is dumped onto a separate barge and towed to a disposal site when disposing in open water.

Code of Federal Regulations. The compilation of Federal regulations adopted by Federal agencies through a rule-making process.

Compositing. Mixing sediments from different samples to produce a composite sample for chemical and/or biological testing.

Confined Disposal. A disposal method that isolates the dredged material from the environment. Confined disposal may be in aquatic, nearshore, or upland environments.

Confined Aquatic Disposal (CAD). Confined disposal in a water environment. Usually ac omplished by placing a layer of sediment over material that has been placed on the bottom of a water body (i.e., capping).

Contaminant. A chemical or biological substance in a form or in a quantity that can harm aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment.

Contaminated Sediment.

Technical Definition: A sediment that contains measurable levels of contaminants.

Management or Common Definition: A sediment that contains sufficient concentration(s) of chemicals to produce unacceptable adverse environmental effects and thus require restriction(s) for dredging and/or disposal of dredged material (e.g., is unacceptable for unconfined, open water disposal or conventional land/shore disposal, requiring confinement).

Conventional Nearshore Disposal. Disposal at a site where dredged material is placed behind a dike in water along the shoreline, with the final elevation of the fill being above water. "Conventional" disposal additionally means that special contaminant controls or restrictions are not needed.

Conventional Pollutants. Sediment parameters and characteristics that have been routinely measured in assessing sediment quality. These include sulfides, organic carbon, etc.

Conventional Upland Disposal. Disposal at a site created on land (away from tidal waters) in which the dredged material eventually dries. Upland sites are usually diked to confine solids and to allow surface water from the disposal operation to be released. "Conventional" disposal additionally means that special contaminant controls or restrictions are not needed.

Depositional Analysis. A scientific inspection of the bottom sediments that identifies where natural sediments tend to accumulate.

Depositional Area. An underwater region where material sediments tend to accumulate.

Disposal. See confined disposal, conventional nearshore disposal, conventional upland disposal, and unconfined, open-water disposal.

Disposal Site. The bottom area that receives discharged dredged material; encompassing, and larger than, the target area and the disposal zone.

Disposal Site Work Group. The PSDDA work group that is designating locations for open-water unconfined dredged material disposal sites that are environmentally acceptable and economically feasible.

Disposal Zone. The area that is within the disposal site that designates where surface release of dredged material will occur. It encompasses the smaller target area. (See also "target area" and "disposal site".)

Dredged Material. Sediments excavated from the bottom of a waterway or water body.

Dredged Material Management Unit. The maximum volume of dredged material for which a decision on suitability for unconfined open-water disposal can be made. Management units are typically represented by a single set of chemical and biological test information obtained from a composite sample. Management units are smaller in areas of higher chemical contamination concern (see "area ranking").

Dredger. Private developer or public entity (e.g., Federal or State agency, port or local government) responsible for funding and undertaking dredging projects. This is not necessarily the dredging contractor who physically removes and disposes of dredged material (see below).

Dredging. Any physical digging into the bottom of a water body. Dredging can be done with mechanical or hydraulic machines and is performed in many parts of Puget Sound for the maintenance of navigation channels that would otherwise fill with sediment and block ship passage.

Dredging Contractor. Private or public (e.g., Corps of Engineers) contractor or operator who physically removes and disposes of dredged material for the dredger (see above).

Disposal Site Work Group. The PSDDA work group that is designating locations for open-water unconfined dredged material disposal sites that are environmentally acceptable and economically feasible.

Ecosystem. A group of completely interrelated living organisms that interact with one another and with their physical environment. Examples of ecosystems

are a rain forest, pond, and estuary. An ecosystem, such as Puget Sound, can be thought of as a single complex system. Damage to any part may affect the whole. A system such as Puget Sound can also be thought of as the sum of many interconnected ecosystems such as the rivers, wetlands, and bays. Ecosystem is thus a concept applied to various scales of living communities and signifying the interrelationships that must be considered.

Effluent. Effluent is the water flowing out of a contained disposal facility. To distinguish from "runoff" (see below) due to rainfall, effluent usually refers to water discharged during the disposal operation.

Elutriate. The extract resulting from mixing water and dredged material in a laboratory test. The resulting elutriate can be used for chemical and biological testing to assess potential water column effects of dredged material disposal.

Entrainment. The addition of water to dredged material during disposal, as it descends through the water column.

Environmental Impact Statement. A document that discusses the likely significant environmental impacts of a proposed project, ways to lessen the impacts, and alternatives to the proposed project. EIS's are required by the National and State Environmental Policy Acts.

Erosion. Wearing away of rock or soil via gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces.

Estuary. A confined coastal water body where ocean water is diluted by inflowing fresh water, and tidal mixing occurs.

Evaluation Procedures Work Group. The PSDDA work group that is developing chemical and biological testing and test evaluation procedures for dredged material assessment.

Gravid. Having eggs, such as female crabs carrying eggs.

Ground Water. Underground water body, also called an aquifer. Aquifers are created by rain which soaks into the ground and flows down until it collects at a point where the ground is not permeable.

Habitat. The specific area or environment in which a particular type of plant or animal lives. An organism's habitat provides all of the basic requirements for life. Typical Puget Sound habitats include beaches, marshes, rocky shores, bottom sediments, mudflats, and the water itself.

Hazardous Waste. Any solid, liquid, or gaseous substance which, because of its source or measurable characteristics, is classified under State or Federal law as hazardous, and is subject to special handling, shipping, storage, and disposal requirements. Washington State law identifies two categories of hazardous waste: dangerous and extremely hazardous. The latter category is more hazardous and requires greater precautions.

Hopper Dredge. A hydraulic suction dredge that is used to pick up coarser grain sediments (such as sand), particularly in less protected areas with sea swell. Dredged materials are deposited in a large holding tank or "hopper" on the same vessel, and then transported to a disposal site. The hopper dredge is rarely used in Puget Sound.

Hydraulic Dredging. Dredging accomplished by the erosive force of a water suction and slurry process, requiring a pump to move the water-suspended sediments. Pipeline and hopper dredges are hydraulic dredges.

Hydraulics Project Approval. RCW 75.20.100 Approval from the Washington Department of Fisheries and Washington Department of Wildlife for the use, diversion, obstruction or change in the natural flow or bed of any river or stream, or that will use any salt or fresh waters of the State.

Hydraulically Dredged Material. Material, usually sand or coarser grain, that is brought up by a pipeline or hopper dredge. This material usually includes slurry water.

Hydrocarbon. An organic compound composed of carbon and hydrogen. Petroleum and its derived compounds are hydrocarbons.

Infauna. Animals living in the sediment.

Intertidal Area. The area between high and low tide levels. The alternate wetting and drying of this area makes it a transition between land and water organisms and creates special environmental conditions.

Leachate. Water or other liquid that may have dissolved (leached) soluble materials, such as organic salts and mineral salts, derived from a solid material. Rainwater that percolates through a sanitary landfill and picks up contaminants is called the leachate from the landfill.

Local Sponsor. A public entity (e.g., port district) that sponsors Federal navigation projects. The sponsor seeks to acquire or hold permits and approvals for disposal of dredged material at a disposal site.

Loran C. An electronic system to facilitate navigation positioning and course plotting/tracking.

Management Plan Work Group. The PSDDA work group is developing a management plan for each of the open-water dredged material disposal sites. The plan will define the roles of local, State, and Federal agencies. Issues being addressed include: permit reviews, monitoring of permit compliance, treatment of permit violations, monitoring of environmental impacts, responding to unforeseen effects of disposal, plan updating, and data management.

Material Release Screen. A laboratory test proposed by PSDDA to assess the potential for loss of fine-grained particles carrying chemicals of concern from the disposal site during disposal operations.

Mechanical Dredging. Dredging by digging or scraping to collect dredged materials. A clamshell dredge is a mechanical dredge. (See "hydraulic dredging.")

Metals. Metals are naturally occurring elements. Certain metals, such as mercury, lead, nickel, zinc, and cadmium, can be of environmental concern when they are released to the evironment in unnatural amounts by man's activities.

Microlayer, Sea Surface Microlayer. The extremely thin top layer of water that can contain high concentrations of natural and other organic substances. Contaminants such as oil and grease, many lipophylic (fat or oil associated) toxicants, and pathogens may be present at much higher concentrations in the microlayer than they are in the water column. Also the microlayer is biologically important as a rearing area for marine organisms.

Microtox. A laboratory test using luminescent bacteria and measuring light production, used to assess toxicity of sediment extracts.

Molt. A complex series of events that results in the periodic shedding of the skeleton, or carapace by crustaceans (all arthropods for that matter). Molting is the only time that many crustaceans can grow and mate (particularly crabs).

Monitor. To systematically and repeatedly measure something in order to detect changes or trends.

Nutrients. Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to accelerated growth of algae and subsequent degradation of water quality due to oxygen depletion. Some nutrients can be toxic at high concentrations.

Overdepth Material. Dredged material removed from below the dredging depth needed for safe navigation. Through overdepth is incidentally removed due to dredging equipment precision, its excavation is usually planned as part of the dredging project to ensure proper final water depths. Common overdepth is 2 feet below the needed dredging line.

Oxygen Demanding Materials. Materials such as food waste and dead plant or animal tissue that use up dissolved oxygen in the water when they are degraded through chemical or biological processes. Chemical and biological oxygen demand (COD and BOD, respectively) are different measures of how much oxygen demand a substance has.

Parameter. A quantifiable or measurable characteristic of something. For example, height, weight, sex, and hair color are all parameters that can be determined for humans. Water quality parameters include temperature, pH, salinity, dissolved oxygen concentration, and many others.

Pathogen. A disease-causing agent, especially a virus, bacteria, or fungi. Pathogens can be present in municipal, industrial, and nonpoint source discharges to the Sound.

Permit. A written warrant or license, granted by an authority, allowing a particular activity to take place. Permits required for dredging and disposal of dredged material include the U.S. Army Corps of Engineers Section 404 permit, the Washington State Department of Fisheries Hydraulics Permit, the city or county Shoreline Development Permit, and the Washington Department of Natural Resources Site Use Disposal Permit.

Persistent. Compounds that are not readily degraded by natural physical, chemical, or biological processes.

Pesticide. A general term used to describe any substance, usually chemical, used to destroy or control organisms (pests). Pesticides include herbicides, insecticides, algicides, and fungicides. Many of these substances are manufactured and are not naturally found in the environment. Others, such as pyrethrum, are natural toxins which are extracted from plants and animals.

pH. The degree of alkalinity or acidity of a solution. Water has a pH of 7.0. A pH of less than 7.0 indicates an acidic solution, and a pH greater than 7.0 indicates a basic solution. The pH of water influences many of the types of chemical reactions that occur in it. Puget Sound waters, like most marine waters, are typically pH neutral.

Phase I. The PSDDA study is divided into two, 3-year long, overlapping phases. Phase I covers the central area of Puget Sound including Seattle, Everett, and Tacoma. Phase I began in April 1985.

Phase II. The PSDDA study is divided into two, 3-year long, overlapping phases. Phase II covers the north and south Sound (including, Olympia, Bellingham, and Port Angeles)--the areas not covered by Phase I. Hood Canal is not being considered for location of a disposal site. Phase II began in April 1986.

Pipeline Dredge. A hydraulic dredge that transports slurried dredged material by pumping it via a pipe. (See "hydraulic dredge".)

Point Source. Locations where pollution comes out of a pipe into Puget Sound.

Polychaete. A marine worm.

Polychlorinated Biphenyls. A group of manmade organic chemicals, including about 70 different but closely related compounds made up of carbon, hydrogen, and chlorine. If released to the environment, they persist for long periods of time and can concentrate in food chains. PCB's are not water soluble and are suspected to cause cancer in humans. PCB's are an example of an organic toxicant.

Polycyclic (Polynuclear) Aromatic Hydrocarbon. A class of complex organic compounds, some of which are persistent and cancer-causing. These compounds are formed from the combustion of organic material and are ubiquitous in the environment. PAH's are commonly formed by forest fires and by the combustion

of fossil fuels. PAH's often reach the environment through atmospheric fall-out, highway runoff, and oil discharge.

Priority Pollutants. Substances listed by EPA under the Clean Water Act as toxic and having priority for regulatory controls. The list includes toxic metals, inorganic contaminants such as cyanide and arsenic, and a broad range of both natural and artificial organic compounds. The list of priority pollutants includes substances that are not of concern in Puget Sound, and also does not include all known harmful compounds.

Puget Sound Water Quality Authority. An agency created by the Washington State legislature in 1985 and tasked with developing a comprehensive plan to protect and enhance the water quality of Puget Sound. The Authority adopted its first plan in January 1987.

Range Markers. Pairs of markers which, when aligned, provide a known bearing to a boat operator. Two pairs of range markers can be used to fix position at a point.

Regional Administrative Decisions. A term used in PSDDA to describe decisions that are a mixture of scientific knowledge and administrative judgment. These regionwide policies are collectively made by all regulatory agencies with authority over dredged material disposal to obtain Sound-wide consistency.

Regulatory Agencies. Federal and State agencies that regulate dredging and dredged material disposal in Puget Sound, along with pertinent laws/permits, include:

U.S. Army Corps of Engineers

- River and Harbor Act of 1899 (Section 10 permits)
- Clean Water Act (Section 404 permits)

U.S. Environmental Protection Agency

- Clean Water Act (Section 404 permits)

Washington Department of Natural Resources

- Shoreline Management Act (site use permits)

Washington Department of Ecology

- Clean Water Act (Section 401 certifications)
- Shoreline Management Act (CZMA consistency determinations)

Washington Department of Fisheries

- Hydraulics Project Approval

Washington Department of Wildlife (Formerly Washington Department of Game)

- o Hydraulics Project Approval

Local shoreline jurisdiction e.g., City of Seattle, City of Everett, Pierce County

- o Shoreline permit to non-Federal dredger/DNR

U.S. Fish and Wildlife Service (Key reviewing agency)

National Marine Fisheries Service (Key reviewing agency)

The Resource Conservation and Recovery Act. The Federal law that regulates solid and hazardous waste.

Respiration. The metabolic processes by which an organism takes in and uses oxygen and releases carbon dioxide and other waste products.

Revised Code of Washington. The compilation of the laws of the State of Washington published by the Statute Law Committee.

Runoff. Runoff is the liquid fraction of dredged materials or the flow/seepage caused by precipitation landing on and filtering through upland or nearshore dredged material disposal sites.

Salmonid. A fish of the family Salmoniidae. Fish in this family include salmon and trout. Many Puget Sound salmonids are anadromous, spending part of their life cycles in fresh water and part in marine waters.

Sediment. Material suspended in or settling to the bottom of a liquid, such as the sand and mud that make up much of the shorelines and bottom of Puget Sound. Sediment input to Puget Sound comes from natural sources, such as erosion of soils and weathering of rock, or anthropogenic sources, such as forest or agricultural practices or construction activities. Certain contaminants tend to collect on and adhere to sediment particles. The sediments of some areas around Puget Sound contain elevated levels of contaminants.

Site Condition. The degree of adverse biological effects that might occur at a disposal site due to the presence of sediment chemicals of concern; the dividing line between "acceptable" (does not exceed the condition) and "unacceptable" (exceeds the site condition) adverse effects at the disposal site. Other phrases used to describe site condition include "biological effects condition for site management" and "site management condition."

Spot Checking. Inspections on a random basis to verify compliance with permit requirements.

State Environmental Policy Act. A State law intended to minimize environmental damage. SEPA requires that State agencies and local governments consider environmental factors when making decisions on activities, such as development proposals over a certain size. As part of this process, environmental documents such as EIS's are prepared and opportunities for public comment are provided.

Statistically Significant. A quantitative determination of the statistical degree to which two measurements of the same parameter can be shown to be different, given the variability of the measurements.

Subtidal. Refers to the marine environment below low tide.

Suspended Solids. Organic or inorganic particles that are suspended in water. The term includes sand, mud, and clay particles as well as other solids suspended in the water column.

Target Area. The specified area on the surface of Puget Sound for the disposal of dredged material. The target area is within the disposal zone and within the disposal site.

Toxic. Poisonous, carcinogenic, or otherwise directly harmful to life.

Toxic Substances and Toxicants. Chemical substances, such as pesticides, plastics, detergents, chlorine, and industrial wastes that are poisonous, carcinogenic, or otherwise harmful to life if found in sufficient concentrations.

Treatment. Chemical, biological, or mechanical procedures applied to an industrial or municipal discharge or to other sources of contamination to remove, reduce, or neutralize contaminants.

Turbidity. A measure of the amount of material suspended in the water. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. Very high levels of turbidity can be harmful to aquatic life.

Unconfined, Open-Water Disposal. Discharge of dredged material into an aquatic environment, usually by discharge at the surface, without restrictions or confinement of the material once it is released.

Variable Range Radar. Radar equipped with markers which allow measurement of bearings and distances to known targets.

Vessel Traffic Service (VTS). A network of radar coverage for ports of Puget Sound operated by the Coast Guard to control ship traffic. Most commercial vessels are required to check in, comply with VTS rules, and report any change in movement.

Volatile Solids. The material in a sediment sample that evaporates at a given high temperature.

Washington Administrative Code. Contains all State regulations adopted by State agencies through a rulemaking process. For example, Chapter 173-201 WAC contains water quality standards.

Water Quality Certification. Approval given by Washington State Department of Ecology which acknowledges the compliance of a discharge with Section 401 of the Clean Water Act.

Waterways Experiment Station (WES). Corps of Engineers (Corps) research facility located in Vicksburg, Mississippi, that performs research and support projects for the various Corps districts.

Wetlands. Habitats where the influence of surface or ground water has resulted in development of plant or animal communities adapted to such aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.

Zoning. To designate, by ordinances, areas of land reserved and regulated for specific land uses.

ABBREVIATIONS

AET. Apparent Effects Threshold.

CFR. Code of Federal Regulations.

Corps. U.S. Army Corps of Engineers.

CWA. The Federal Clean Water Act, previously known as the Federal Water Pollution Control Act.

DEIS. Draft Environmental Impact Statement.

DMRP. Dredged Material Research Program.

DNR. Washington Department of Natural Resources.

DSS TA. Disposal Site Selection Technical Appendix.

DSWG. Disposal Site Work Group.

Ecology. Washington Department of Ecology.

EIS. Environmental Impact Statement.

EPA. Environmental Protection Agency.

EPTA. Evaluation Procedures Technical Appendix.

EPWG. Evaluation Procedures Work Group.

FVP. Field Verification Program.

HPA. Hydraulics Project Approval. RCW 75.20.100.

ML. Maximum Level.

MPTA. Management Plans Technical Appendix.

MPWG. Management Plan Work Group.

NEPA. National Environmental Policy Act.

PAH. Polycyclic (Polynuclear) Aromatic Hydrocarbon.

PCB's. Polychlorinated Biphenyls.

PMP. Proposed Management Plan.

PSDDA. Puget Sound Dredged Disposal Analysis.

PSEP. Puget Sound Estuary Program.

PSIC. Puget Sound Interim Criteria.

PSWQA. Puget Sound Water Quality Authority.

RAD's. Regional Administrative Decisions.

RCRA. The Resource Conservation and Recovery Act.

RCW. Revised Code of Washington.

SEPA. State Environmental Policy Act.

SL. Screening Level.

SMA. Shoreline Mangement Act.

WAC. Washington Administrative Code.

WES. Waterways Experiment Station.

401. Section 401 of the Clean Water Act.

404. Section 404 of the Clean Water Act.

4MR. The Fourmile Rock DNR disposal site in Elliott Bay.